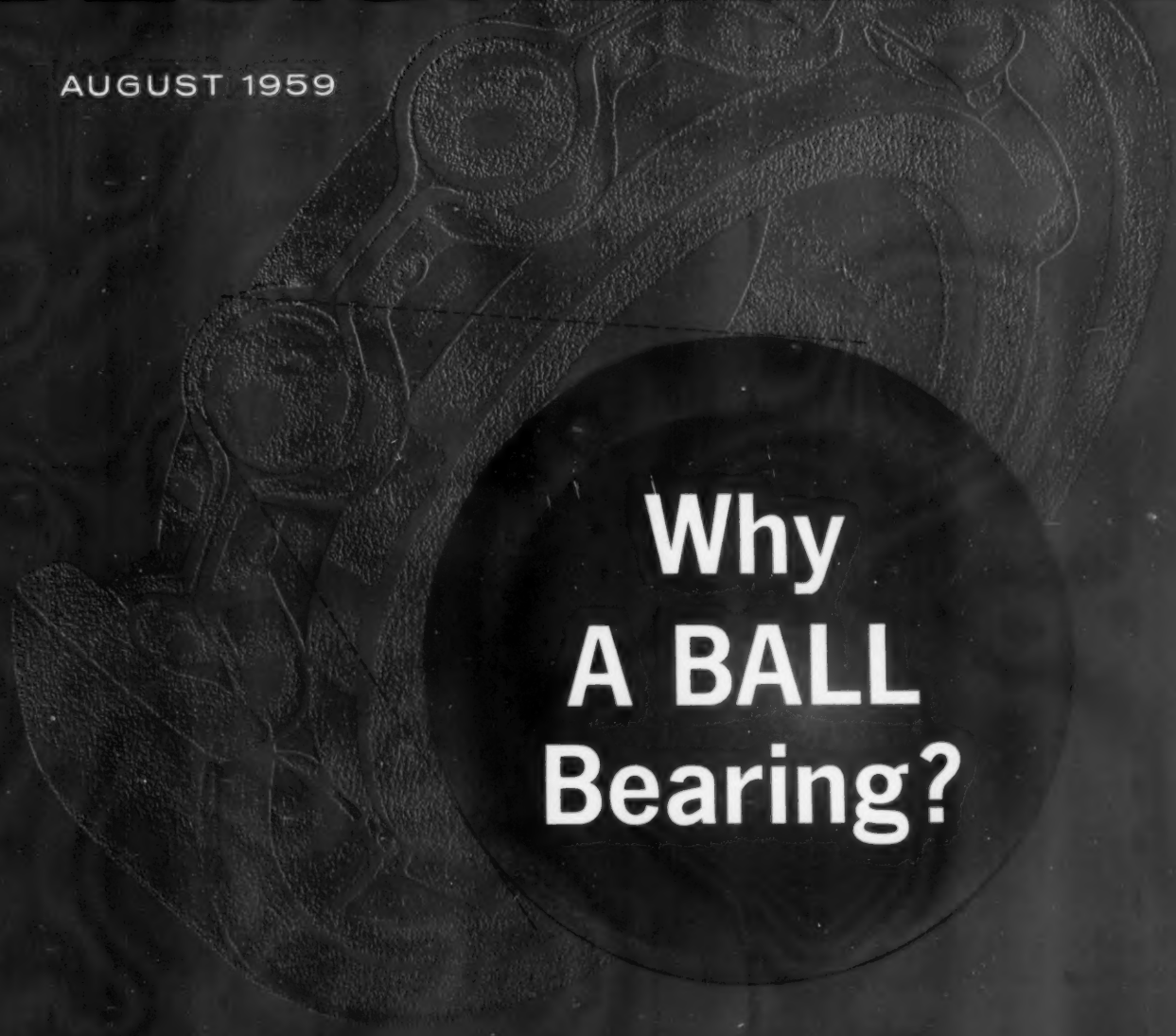
POWER TRANSMISSION DESIGN

OEM··MAINTENANCE

AUGUST 1959



Why A BALL Bearing?

THE MAGAZINE OF MACHINE DRIVES

News and ideas for designers and plant engineers who use power drive equipment

For PERFECT BALANCE Specify

Genuine MECHANICS *Roller Bearing* UNIVERSAL JOINTS

For Cars • Trucks • Tractors • Farm Implements • Road Machinery • Aircraft • Tanks • Busses and Industrial Equipment

The Mechanics Universal Joint has a brake mounting that attaches the brake disc, or drum, to the transmission flange—*independent of the bolts that attach the joints to the flange*. This exclusive Mechanics feature makes it possible to balance the flange and drum—as a unit.

The accurate balance of the brake assembly is not disturbed, when installing the joint, because the bolts that attach the brake drum do not attach the universal joint to the flange—nor carry the universal joint torque. Thus the balance obtained on the balancing machine is maintained after installation of the joint in your product.

Let our engineers show you how this exclusive MECHANICS Roller Bearing UNIVERSAL JOINTS advantage will help improve the operation of your product.

Export Sales: Borg-Warner International
79 E. Adams, Chicago 3, Illinois

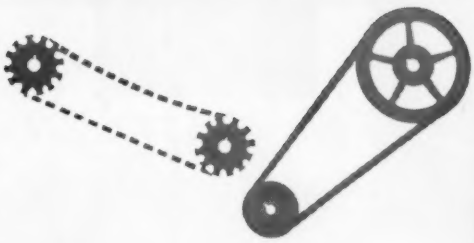
MECHANICS UNIVERSAL JOINT DIVISION

Borg-Warner • 2038 Harrison Ave., Rockford, Ill.

For more information circle No. 13 on the Reader Service Card

maurey DRIVES

make productive machines



Maurey V-Drives and Roller Chain Drives upgrade a machine three important ways:

PRODUCTION-wise
They drive the full power of the motor into your machine's productive "muscles."

DESIGN-wise
They conserve space for modern trimness.

MAINTENANCE-wise
They make repairs and replacements, when necessary, simple, quick and low in cost.

Why not give your machine the production lift and the modern look that a Maurey Drive assures? A Maurey power transmission specialist will be glad to help with your drive plans, at no obligation. And you can depend on Maurey delivery to keep your production on schedule.

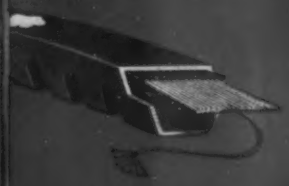
Call your local Maurey Drive distributor, or write for any one or all of these Maurey Power Transmission Catalogs:

- FHP V-Drive Catalog F-10
- V-Belt Catalog No. 55
- Multiple V-Drive Catalog, MVD-58
- Maureymatic Variable Speed Transmission Catalog No. MM-58
- V-Drive Engineering Manual
- Roller Chain Drive Catalog D-58
- Conveyor Pulley Catalog CV-1

the complete, engineered drive line

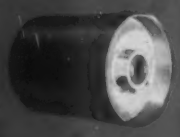
Hi-Q FHP V-Pulleys

FUL-GRIP Q-D Sheaves



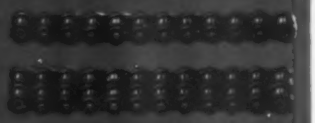
Mor-Grip Green Seal V-Belts

Maureymatic
Variable Speed Transmissions



Conveyor Pulleys

Sprockets



Roller Chains

And a complete line
of Drive Accessories

maurey MANUFACTURING CORPORATION
2907-23 S. WABASH AVENUE, CHICAGO 16, ILLINOIS

Fast Service From These Maurey Warehouses

CLEVELAND: 3200 Lakeside Avenue · Phone: MAin 1-2242 • **KANSAS CITY, Mo.:** 1728 Walnut · Phone: BAltimore 1-3330

For more information circle No. 12 on the Reader Service Card

POWER TRANSMISSION DESIGN

FRANCHISE CIRCULATION

J. C. SALETTE, JR. .....general manager
DAVID R. CARTWRIGHT .....editor
KEITH A. CARLSON ....managing editor
DAVID JENNESS .....assistant editor
W. A. WILLIAMS .....consulting editor
HENRY LEFER .....eastern editor
SCHOLER BANGS .....western editor
DR. DAVID KINSLER ....distilled writing
ALARIC MAUSSER .....art director
N. G. KISER .....circulation manager
R. BLACK .....reader service mgr.

FRANCHISE DEPARTMENT

ALAN J. KICHLER .....general manager
F. M. MASON .....representative
ROBERT LEADBETER .....production

SALES OFFICES

Cleveland 15
812 Huron Rd., SU-1-9620
HARRY O. ANDREWS

New York City 17
Rm. 835, 60 E. 42 St., MU 7-3420
LEE HAAS, vice president
ART JOYCE

Chicago 11
Rm. 704, 520 N. Michigan, WH 3-1655
CHARLES F. GEYER, vice president
ROBERT B. NELSON
SAM TRACY

Los Angeles 57
Rm. 8, Granada Building
672 S. Lafayette Park Pl., DU 7-5104
ALAN T. CAZIER, manager

London, S.W. 1
31 Palace St., Westminster, VI 2608
JOHN A. LANKESTER, manager

POWER TRANSMISSION DESIGN

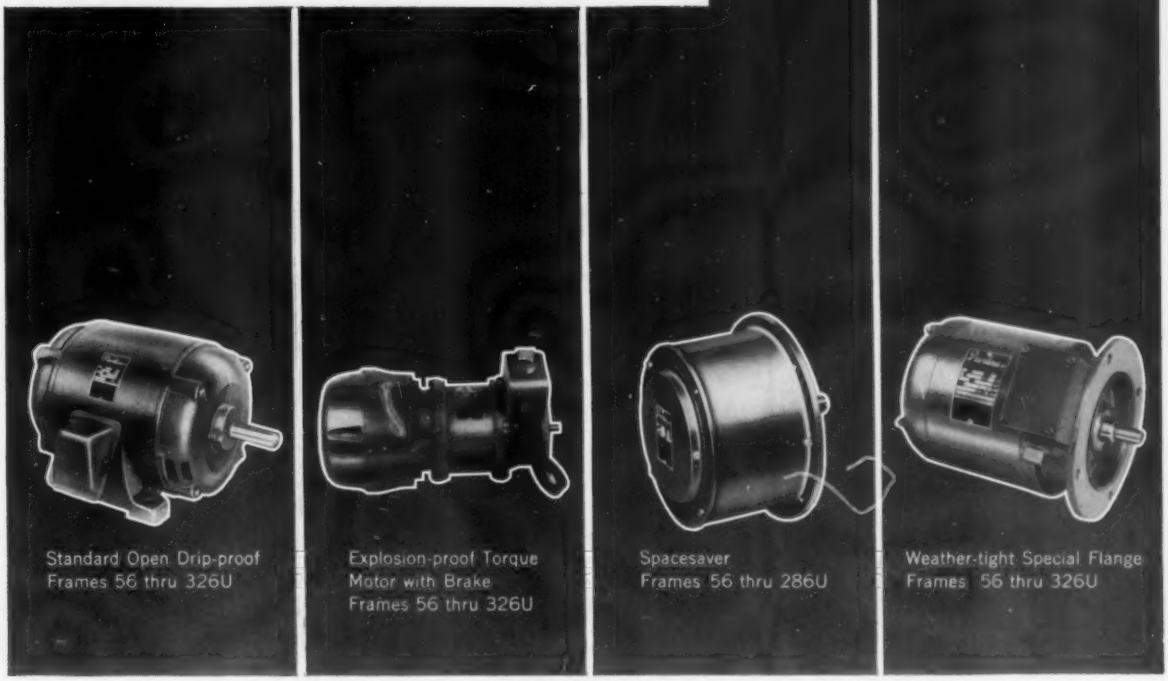
is published monthly and copyright 1959 by Power Publishing Company, Inc., a subsidiary of The Industrial Publishing Corporation, 812 Huron Rd., Cleveland 15, Ohio.

IRVING B. HEXTER .....president
LESTER P. AURBACH .....executive v. p.
EDWIN M. JOSEPH .....vice president
LEE HAAS .....vice president
E. J. HEXTER .....vice president
CHARLES F. GEYER .....vice president
ALAN J. KICHLER .....asst. sec./treas.

SUBSCRIPTIONS in U. S. and possessions: $7, 1 year; $12, 2 years. Canada: $8 per year. Foreign: $10 per year, payable in advance in U.S. funds. U.K.: £3.50 per year payable in Sterling to London office.

AFFILIATED PUBLICATIONS: Applied Hydraulics & Pneumatics, Welding Design & Fabrication, Material Handling Engineering (formerly Flow), Material Handling Illustrated, Modern Office Procedures, Occupational Hazards, Precision Metal Molding, The Refrigeration & Air-Conditioning Business, Welding Illustrated. Accepted as a controlled circulation publication at Pontiac, Illinois. Return form 3579 to 812 Huron Rd., Cleveland 15, Ohio.

if you use TORQUE MOTORS



Standard Open Drip-proof
Frames 56 thru 326U

Explosion-proof Torque
Motor with Brake
Frames 56 thru 326U

Spacesaver
Frames 56 thru 286U

Weather-tight Special Flange
Frames 56 thru 326U

RATINGS FROM 2 OZ. IN. to 200 LB. FT.

NEW TORQUE BULLETIN
This bulletin outlines basic facts about Peerless torque motors and shows applications. It is available FREE. Write for it today.

These Peerless torque motors deliver maximum rated torque without damage to the windings when stalled across the line at full voltage for predetermined periods. Peerless also builds torque motors which provide a nearly constant torque while operating at less than synchronous speeds.

All standard frame sizes; all types of mountings; high torques; special paint and varnish treatments; and Class A, B, F, and H insulation are available at Peerless. The special attention and close cooperation required on torque motor design and application have made Peerless a leader in the field. Give your torque motor problem to the Peerless engineers. They'll work with you to develop the torque motor that powers your product best.

ELECTRIC MOTOR DIVISION

THE Peerless-Electric® COMPANY

FANS · BLOWERS · MOTORS

1512 W. MARKET ST. · WARREN, OHIO

For more information circle No. 14 on the Reader Service Card

READERS' GUIDE

August 1959, *volume 1 number 8*

FEATURE SECTION

16 OVERRUNNING CLUTCHES PERFORM DUAL-SPEED SELECTION
By Charles E. Cleland

18 KEEP YOUR POWER SOURCE CLOSE TO YOUR WORK
By Daniel Brandt

IDEAS FOR DESIGNERS AND PLANT ENGINEERS

23 HYDRO-MECHANICAL DRIVE GIVES SMOOTH DECELERATION

24 OVERRUNNING CLUTCH PREVENTS SHUTDOWN

25 AIR SHIELDED PILLOW BLOCK PREVENTS ABRASION

26 PNEUMATIC BRAKES GIVE PRECISE TORQUE CONTROL

28 CLUTCH-NUTS PERFORM MULTIPLE FUNCTIONS

30 DOUBLE-SIDED V-BELT DRIVES CONTRAROTATING CUTTERS

30 FOUR WORMS SYNCHRONIZE EIGHT ROLLS

31 LEATHER-FACED CLUTCHES TRANSMIT POWER SMOOTHLY

DEPARTMENTS

NEWS 6
MEN 10
EDITOR'S PAGE 14
NEW PRODUCTS* 33
NOMOGRAMS 56
LITERATURE* 55
ABSTRACT 60
AD & PRODUCT INDEXES 64

FACTS

and figures on products and literature of interest to designers, engineers, and other power transmission design people can be had by circling the right numbers on the reader service cards found opposite page 48.

BEARING SECTION

42 YOU CAN ALWAYS DEPEND ON A BALL BEARING

REFERENCE FILE

56 NOMOGRAMS FOR COMPLETE MULTIPLE V-BELT DRIVE
By J. N. Arnold and Allan C. Dunk

ABSTRACTS

60 FINE-PITCH WORM AND HELICAL GEAR SETS
By E. D. Knab

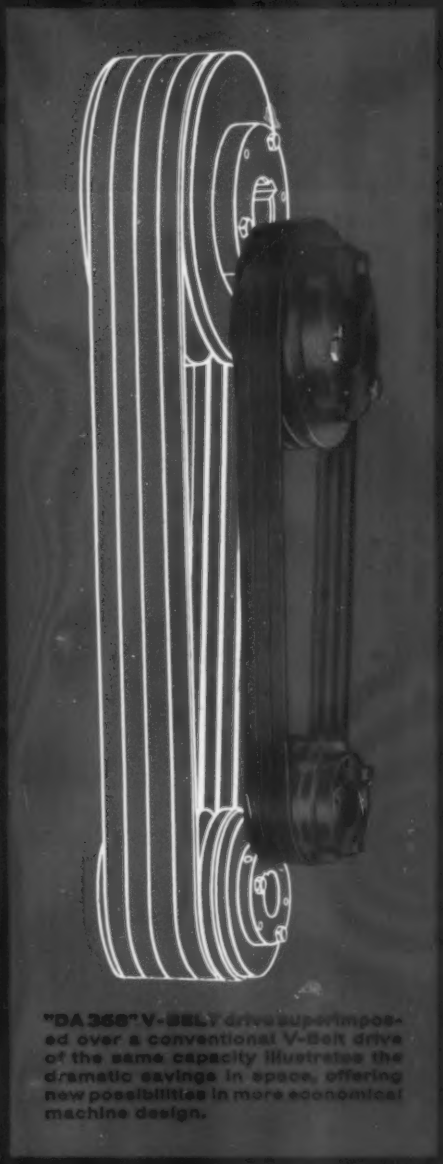
Now . . . from Durkee-Atwood

DA 358 V-BELTS

Introducing the entirely new V-Belt concept for compact, Plus-Power Drives

From Durkee-Atwood, pioneer manufacturer of high quality V-Belts for industry, comes the great new "DA 358" V-Belt, opening up completely new opportunities for highly compact, economical multiple V-Belt drives. "DA 358" V-Belts are engineered for unprecedented power transmission as compared with conventional V-Belts . . . with the ability to transmit more horsepower in a given area, at less cost, and with fewer belts, smaller, lighter sheaves and shorter center distances. They are manufactured with the quality and precision for which Durkee-Atwood is famous—quality which *we invite you to test.* Manufactured in 3V, 5V and 8V sizes.

SPECIAL: Durkee-Atwood's new "Red Shield" V-Belts now have a ***horsepower rating 40 per cent higher than former Standard V-Belts***—part of a major V-Belt upgrading program for improved drive design.



"DA 358" V-BELT drive superimposed over a conventional V-Belt drive of the same capacity illustrates the dramatic savings in space, offering new possibilities in more economical machine design.

We invite you to test DA 358 V-Belt against all other V-Belts

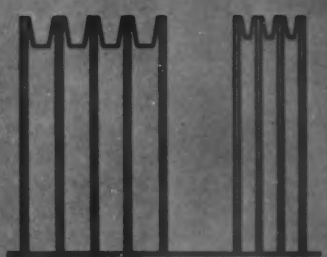
Write on your letterhead giving data, and we will forward to you our engineering recommendations.

Write

DURKEE-ATWOOD COMPANY

MINNEAPOLIS 13, MINNESOTA

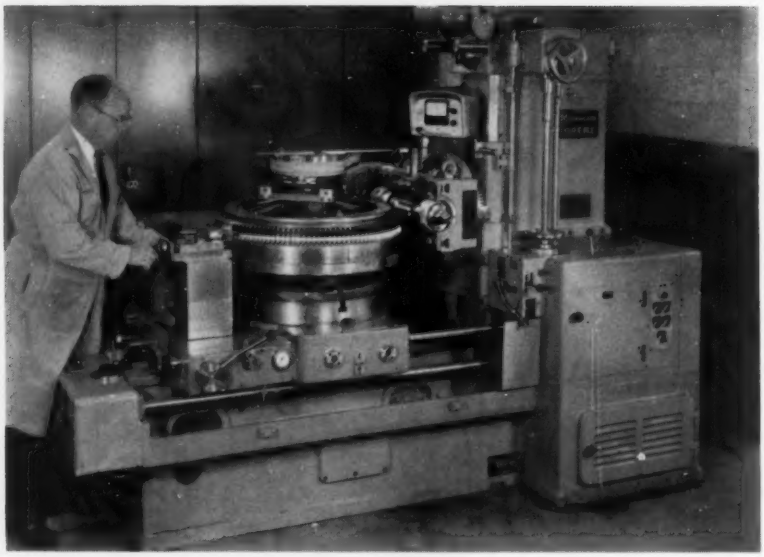
Look for the DA *on your V-Belts*



SHEAVE WIDTHS are sharply reduced with a "DA 358" V-Belt drive. Figure at left shows sheave width for a conventional drive. Figure at right is sheave width for a comparable "DA 358" V-Belt drive.

For more information circle No. 6 on the Reader Service Card

NEWS *from the power transmission field*



U. S. firm markets Lorenz line

DETROIT, MICH.—Michigan Tool Company will produce and market domestic versions, with important modifications, of the well-known Lorenz German line of gear shapers and hobbing machines, it was recently announced.

The machines, which round out the company's lines of gear production and checking machines, will soon be available conforming to JIC standards and carrying U. S. electrical equipment and controls. They will be marketed under the name Michigan-Lorenz in this country.

The new line of gear shapers is intended for fully automatic or semi-automatic production of spur and helical gears of both the internal and external types in standard profiles. There are four standard models for gears up to 20 inches diameter. In addition, there are two models for shaper cutting of closed-gap type herringbone gears and a seventh machine for cutting racks up to six feet long.

Two series of hobbers in a total of seven models are designed for versatility and accuracy and complement the company's existing line of high-production hobbers. They are of the heavy-duty type, one series for medium size gears up to three and four feet in diameter and another for larger sizes. All are vertical single-spindle types, ruggedly built and extremely accurate, and suitable for either large or small, job-lot runs. All models are available with or without automatic loading and unloading equipment.

Indicative of the accuracy of the Michigan-Lorenz hobbers is the set-up shown above for checking the cutting of a double-enveloping worm gear on a medium-capacity hobber. Cumulative tooth spacing errors check out to a maximum of only 14 seconds.

Bernstein's 60th birthday

PATERSON, N. J.—1959 marks the 60th anniversary of the founding of Bernstein Brothers, Inc., Paterson, N. J. The firm deals with pumps, compressors, belting and complete engineering and planning services for many industrial leaders.

Dayton Rubber-Raybestos distribution deal

DAYTON, OHIO—Dayton Rubber Company will soon begin production of Poly-V power transmission belts as a result of an exclusive licensing arrangement with Raybestos-Manhattan. Inc., Passaic, New Jersey.

The latter firm developed the Poly-V belt which has parallel ribs on the inner surface matching corresponding grooves on the sheaves, giving additional gripping surface and pulling power.

Marketing of the belts through Dayton's field sales organization will extend the coverage of its existing line of V-belts to areas not previously covered, according to R. G. Burson, Dayton vice president. He cited the belts' ability to operate efficiently over a full range of machinery power requirements from the smallest movie projectors to huge oil field slush pumps.

Dodge establishes Australian facility

MISHAWAKA, IND.—Dodge Mfg. Corp. has announced formation of a new Australian company to manufacture their products. The company is Fenner Dodge (Australia) Pty. Ltd. and is jointly owned by Dodge and J. H. Fenner & Co. Ltd., Hull, England. Dodge owns 40% of the new firm and Fenner owns 60%. Fenner manufactures Dodge-patented products in England under license.

Fenner will operate the new company and Dodge will contribute technical counsel in developing manufacturing facilities. Manufacturing began in April in a 20,000-sq-ft factory on the outskirts of Sydney.

Hewitt-Robins in Italy

STAMFORD, CONN.—A new wholly-owned subsidiary based in Genoa, Italy has been announced by Hewitt-Robins, Inc. Complete market coverage of the company's power transmission equipment and industrial rubber products is planned.

Hewitt-Robins (Italia) will be the company's sixth foreign subsidiary, the others being in Holland, England, Canada, France and South Africa.

Continued on page 8

Send for this *NEW* Twin Disc engineering guide

You'll find up-to-date specifications on every drive in the Twin Disc line in Bulletin 314—a brand-new 20-page brochure packed with technical data on construction details, dimensions, capacities and application recommendations. If you're engaged in designing new equipment drive lines, you'll want to keep Bulletin 314 handy as an accurate reference guide to the proper type and size of power transmission unit for any application.

Since 1918, Twin Disc industrial drives have earned a world-wide reputation for sound design and quality construction. And the Twin Disc line is *complete*. It includes mechanical, air, oil and electrically actuated friction clutches, fluid couplings, friction and fluid PTO's, single-stage and three-stage torque converters and marine gears. The fact that Twin Disc makes so many different types of drives is worth remembering. It means that Twin Disc engineers can offer *completely unbiased recommendations* whenever there's a question of drive selection.

Put Twin Disc engineering data at your fingertips . . . get your copy of Bulletin 314 *now*. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin. Hydraulic Division, Rockford, Illinois.

Mail This Coupon Today

TWIN DISC CLUTCH COMPANY
Racine, Wisconsin

Please send me a copy of your new Bulletin No. 314 covering specifications on all Twin Disc Friction and Fluid Drives.

Name_____

Title_____

Company_____

Street_____

City_____ State_____

For more information circle No. 18 on the Reader Service Card

NEWS *continued from page 6*

Dynamic Gear begins expansion program

AMITYVILLE, N. Y.—Installations in Atlas, Thor and Titan missiles, the wide use of the Dynaco line of precision gears in other phases of the government's defense program such as the Navy's Polaris project, and growing acceptance of the gear line in the commercial field have combined to bring about long-range expansion plans by the Dynamic Gear Co. of Amityville, N. Y.

According to William Wiegand, president, considerable overtime on a two-shift schedule pointed to a critical need for a 50 per cent increase in production facilities. This need has been met in a new plant in nearby Copiague that today houses Dynamic's entire general machine shop.

Chain Belt organizes overseas corporations

MILWAUKEE, WISC.—Three overseas combines have been established by Chain Belt Co. in cooperation with existing companies abroad.

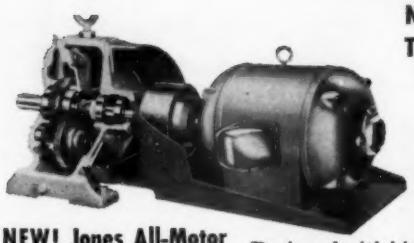
Rex-Chabelco A. G. in Switzerland, Rex-Regina S. A. in Italy and Chain Belt (Japan) Ltd. will all market their products in Europe, Asia and Africa, taking advantage in Europe of the common market which lifts tariff barriers.

A new plant in Olginate, Italy, is being built to make steel roller chains of ¾-in. and heavier pitch for power transmission and conveying.

News from AGMA

WASHINGTON, D.C.—American Gear Manufacturers Association reports that the 43rd annual meeting, held June 1 to 3 in Hot Springs, Va., was the largest and most successful to date.

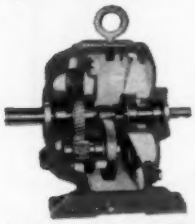
Officers for 1959-60 are J. L. Buehler (president, Indiana Gear Works), president; J. F. Murray (president, Winsmith, Inc.), vice president, product division; F. Richardz (consulting specialist, Westinghouse Electric), vice president, technical division; C. F. Bannan (vice president, Western Gear Corp.), treasurer; and J. C. Sears, the association's executive director.



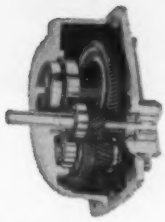
NEW! Jones Integral Type Gearmotors

NEW! Jones All-Motor Type Gearmotors

Designed with high-hardness gearing for longer life. One-piece low-speed end housing construction insures gear alignment and prevents oil leakage. Compact design. All three types available for foot-mounted or flange-mounted installation, and for horizontal or vertical application. Capacity is up to 250 hp.



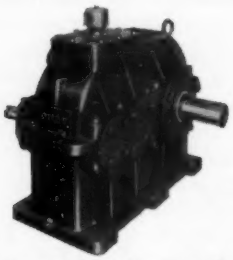
NEW! Jones In-Line Helical Reducers



NEW! Jones Shaft-Mounted Reducers

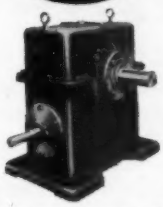
High-hardness gearing gives compact design and extra service life. Positive sealing against oil leakage through double lip type seals. All gearing straddle-mounted between anti-friction bearings. Single and double reduction units to 40 hp. Six standard sizes. Flange-mounted units available in three standard sizes.

NOW!



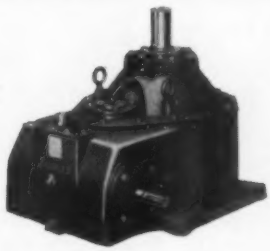
Jones Herringbone Gear Reducers

Accepted throughout industry; balanced design, heavy-duty roller bearings, rugged cast iron housing for reliable service and low maintenance costs. The most complete parallel shaft line in industry.



Jones Worm Gear Reducers

Horizontal and vertical shaft types available with ratios to 80:1. Heavy-duty roller bearings throughout with high-test cast iron housings for positive gear alignment.



Jones Worm-Helical Reducers

For vertical output shaft service; ratios from 25.63:1 to 357.5:1. Provide optimum combination of initial cost, efficiency, and low maintenance. Proven in hundreds of installations; redesigned to incorporate latest improvements in metallurgy and reducer design.

Now from Jones:

SPEED REDUCERS FOR EVERY PURPOSE

One of the most comprehensive speed reducer lines in industry! With new shaft-mounted reducers, in-line helical reducers, and gearmotors, Jones now offers a wide selection for all your power transmission needs. New technical bulletins give you exactly the information you need for proper selection of units in accordance with latest A.G.M.A. ratings. Be sure to ask your Jones representative for copies, or write Hewitt-Robins, Stamford, Connecticut, for this literature:

All-Motor and Integral Type Gearmotors
Bulletin 8-22-J17

In-Line Helical Reducers
Bulletin 8-22-J18

Shaft-Mounted Reducers
Bulletin 8-22-J19

Herringbone Gear Reducers
Bulletin 8-22-100

Worm Gear Reducers
Bulletin 8-22-J13

Worm-Helical Reducers
Bulletin 8-22-J14

HR HEWITT-ROBINS

THE NAME THAT MEANS EVERYTHING IN BULK MATERIALS HANDLING SYSTEMS . . .

CONVEYER BELTING AND IDLERS • POWER TRANSMISSION DRIVES • INDUSTRIAL HOSE • VIBRATING CONVEYORS, SCREENS & SHAKEOUTS

For more information circle No. 10 on the Reader Service Card

MEN *of the power transmission industry*

Habach

Mumma

Vice presidents at Worthington Corp.

HARRISON, N. J.—Appointments of George F. Habach and Rear Admiral (Ret.) Albert G. Mumma as vice presidents of the Worthington Corp. were recently announced by Walther H. Feldman, president.

Habach, previously vice president, engineering, advances to the newly-created post of vice president, administration, with responsibility in the areas of employee and public relations, engineering, manufacturing, marketing, purchasing, and finance. Joining Worthington in 1929, Habach served as development engineer, chief engineer of the centrifugal pump department, and manager of engineering for the Harrison division. He was elected vice president, engineering, in 1955.

Admiral Mumma, until his recent appointment, was Chief of the Bureau of Ships and Coordinator of Shipbuilding for the Defense Department. He now succeeds Habach as vice president, engineering.

Graduated from the Naval Academy in 1926, Admiral Mumma was a member, during World War II, of the ALSOS Mission which investigated German atomic bomb and naval development. He later served in Europe with the Naval Technical Mission which brought to the United States Hellmuth Walter, who helped to develop the German snorkel submarine and who is now director of research at Worthington.

Industrial sales manager for Morse Chain

ITHACA, N. Y.—James W. Torrant is the new industrial sales manager of Morse Chain Co., a Borg-Warner industry, Ithaca, N. Y.

New product managers at Dayton Rubber

DAYTON, OHIO—Two product manager appointments were recently made at Dayton Rubber Co.

A. L. Schriml will head the sales promotion and merchandising program for Dayton's Poly-V drive line. Schriml joined the company in 1936.

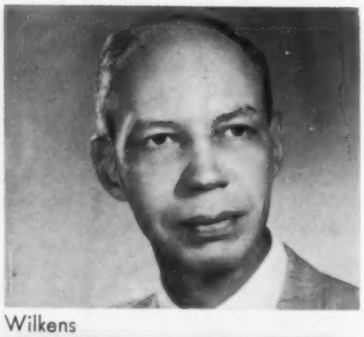
J. R. South becomes product sales manager of the Urethane division, and will be responsible for sales of all flexible and rigid urethane foams. South joined the company in 1948.

Sales promotions at Raybestos-Manhattan

PASSAIC, N. J.—R. B. Parks, formerly San Francisco district manager, has been appointed assistant sales manager for industrial rubber products and packings, Raybestos-Manhattan, Inc. He will lead a new marketing group section of the company's sales division.

At the same time, S. J. Synnott became general marketing manager of industrial rubber products, coordinating marketing efforts of specific product groups.

Hewitt-Robins names Allen, Wilkens



Wilkens

Allen

STAMFORD, CONN.—Recent appointments at Hewitt-Robins, Inc., make Robert R. Allen director of engineering, research and development, and M. R. Wilkens sales planning manager of the industrial products division.

Allen, formerly vice president of engineering and research of the John Wood Company, New York, has had wide experience in product development and engineering management in industry. In 1946 he established his own firm, specializing in the development and manufacture of scientific and aeronautical instruments, for example the ultra microtome for the electronic microscope.

Wilkens joined Hewitt-Robins in 1946. Previously he was associated with Bell Aircraft Corp. and Ryan Aeronautical Corp. As sales planning manager of the industrial products division, he will coordinate marketing efforts with field sales and manufacturing units.

Bass

American Pulley names Bass sales manager

PHILADELPHIA, PA.—Walter C. Bass has been appointed general sales manager of The American Pulley Co., Philadelphia. He will be responsible for all phases of marketing for American's power transmission, materials handling and Hubbard spool divisions.

Bass was formerly Eastern sales manager of Foote Bros. Gear and Machine Corp.

Drum

U. S. Rubber division market manager

NEW YORK, N. Y.—Newly appointed marketing manager of U. S. Rubber Co.'s mechanical goods division is John V. Drum.

Drum assumes marketing supervision of power transmission and other products manufactured at the company's Philadelphia, Providence and Passaic plants. His past experience includes the positions of vice president in charge of sales at Detroit Brass & Malleable Co., and Graham-Page Motors.

Continued on next page

MEN *continued from preceding page*

Allis-Chalmers names Hubbell

MILWAUKEE, WISC.—Allis-Chalmers Manufacturing Co. has appointed Roger S. Hubbell assistant to the vice president, staff operations. In this capacity he will handle special assignments, including salary services.

Hubbell had been manager, wage research services, of the Industrial and Community Relations division since 1948. He joined the company in 1940.

Lord names manager of new Florida field office

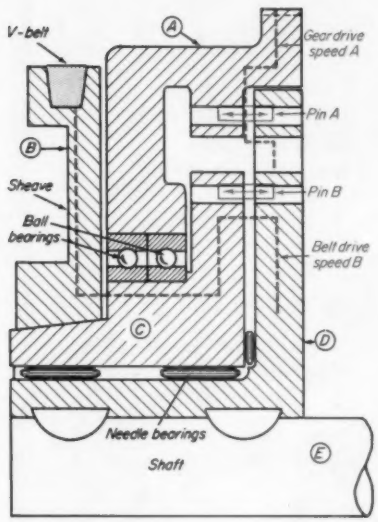
ERIE, PA.—Raymond R. Chartraw is the manager of Lord Manufacturing Co.'s recently-opened field engineering office in Winter Park, Florida.

Chartraw, prior to his new assignment, was a field engineer in the Chicago area for Lord, which produces systems for vibration, shock and noise control. In this capacity he participated in several missile guidance programs.

Letters to the Whatzzit Contest

Entry Type 1—**WANTED:**

Two-speed pulley for machining different metals?



A SIMPLE, two-speed pulley for driving a shaft powered with either V-belt or spur gear.

When belt is driving, sheave connects to output shaft through an idler mounted between ball and needle bearings driving shaft through connecting pin *B*. Pin can be manually or automatically engaged.

When gear is driving, sheave pin is disconnected. Gear pin is engaged and drives output shaft through pin *A* at different speed.

Two-speed pulley can be used as quick speed change for lathes and other machine tools used on different metals—such as stainless steel and aluminum.

R. J. Martin
Chief Engineer
Oster Manufacturing Co.
Wickliffe, Ohio

What is Whatzzit Contest?

Whatzzit contest is an opportunity for you, readers of POWER TRANSMISSION DESIGN, to pass along ideas you've had in the back of your minds for a long time that could help yourself or someone else work out power transmission problems.

Two Types of Entries

Your entries may be:

(1) An idea representing something you could build into actual hardware if you wanted to but have never had reason or need to do so.

(2) An idea of some mythical thing you could use, if it were available, and which you have never seen or heard of on the market.

For instance, a type 1 idea might be a simple design of a journal bearing made of organic fibers you work with in a textile mill, and you feel have tremendous frictionless properties if only someone would try them out as a bearing.

A type 2 idea might be a design of a 9-speed gear box that you could use in your work, if one existed, but which you've never seen or heard about.

Whatzzit Contest Rules

Whatzzit contest letters should be addressed to:

Whatzzit Contest
% The Editor
POWER TRANSMISSION DESIGN
812 Huron Road,
Cleveland 15, Ohio

Entries should include a penciled sketch of the idea on any kind of paper and a brief description in 100 words or less. No formality is required. An honorarium of $10.00 will be paid for those published. All entries become the property of Power Publishing Co., Cleveland, Ohio. Publication is not an endorsement of workability or guarantee of statements made. Contest is offered only as a means of stimulating ideas and rendering service to others who may be able to apply these ideas to end uses.

EDITOR'S PAGE

David R. Cartwright
editor

IF YOU TEAR OUT AND SAVE . . .

. . . the following articles, over the next year and a half, you will have one of the most up-to-date personal reference libraries available on power transmission.

The articles are prepared especially for filing. When you're done, your file will be more comprehensive than any manual in your central library.

Ask for extra free reprints if your copy is dismembered before you get it. Stash them away in a manila folder or loose-leaf notebook and keep them at your desk for quick use. Here's the list for the first eight months:

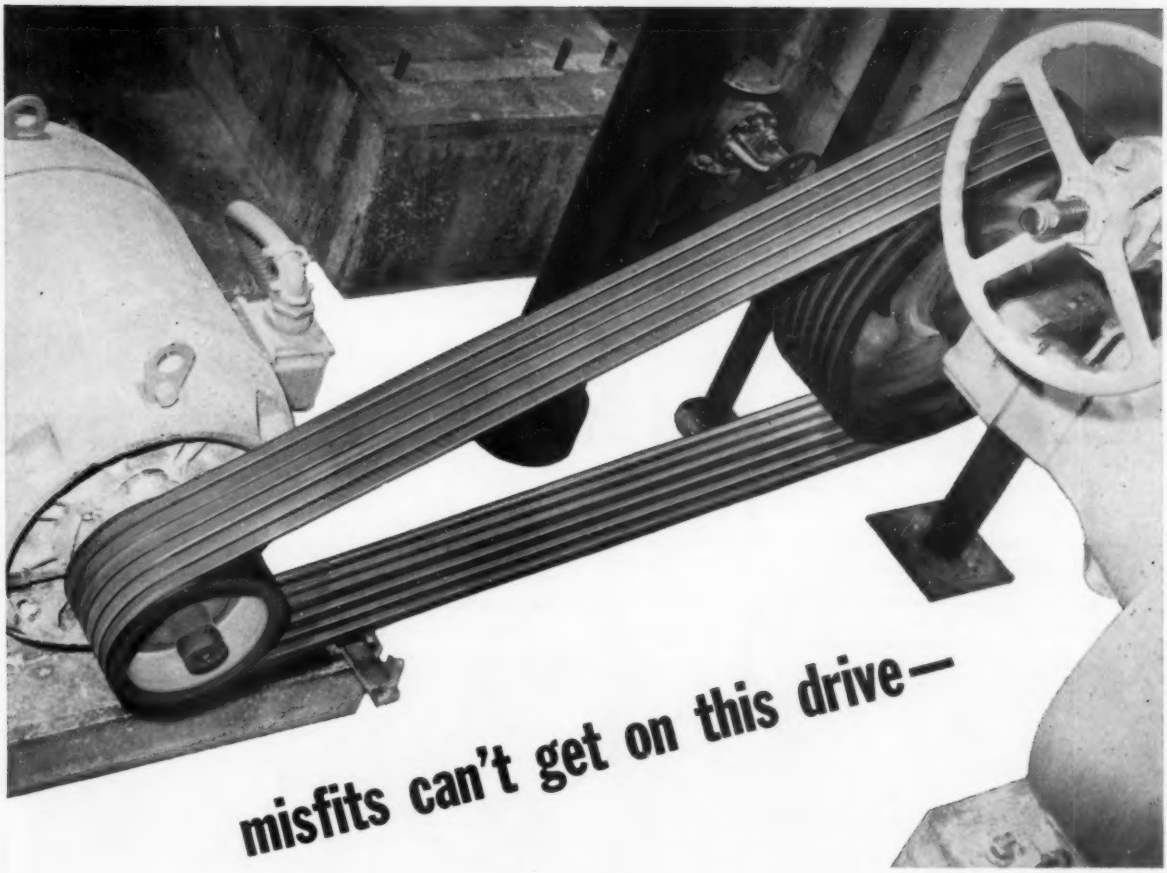
This issue . . . . . **Ball bearings, page 42**
September . . . . . **Roller bearings**
October . . . . . **Sleeve bearings and bushings**
November . . . . . **Variable speed drives (electrical)**
December . . . . . **Variable speed drives (mechanical, hydraulic)**
January, '60 . . . . . **Gearmotors**
February . . . . . **Gear boxes, speed reducers**
March . . . . . **Clutches, brakes, couplings**

We'll list the remaining ones later. When you're done, you'll have data on bearings, speed reducers, seals, lubrication systems, motors, engines, gears, belts, chain, universal joints, shafts, lubricants, controls and many others.

Dave Cartwright

Editor

ROYAL V-BELTS



THE BELTS ARE U.S. ROYAL

The above drive in the plant of a large paper manufacturer proves again the perfect matching of U. S. Royal V-Belts. They are *born matched . . . and stay matched*.

This matchability has been demonstrated again and again with U. S. Royal V-Belts from Maine to California. You can call any U. S. V-Belt Distributor, specify the belt size and then receive belts of perfect match without delay. Why? Because the distributor serves you immediately from stock, is freed from the time-wasting job of putting belts (in all sizes up to 180") on a matching machine. Rejects just don't happen.

U. S. Royal V-Belts excel because they are made by entirely new methods of curing, they have new pulling members, new jackets incorporating new technical advances in rubber.

• • •

When you think of rubber, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.

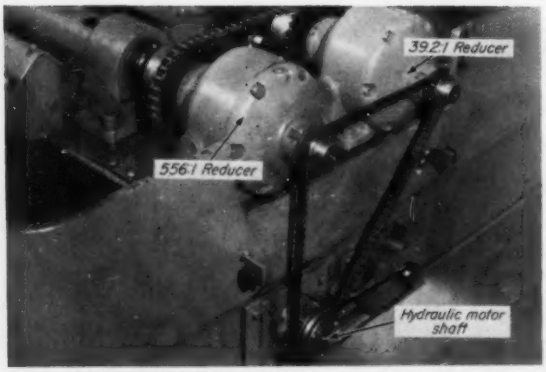
Mechanical Goods Division

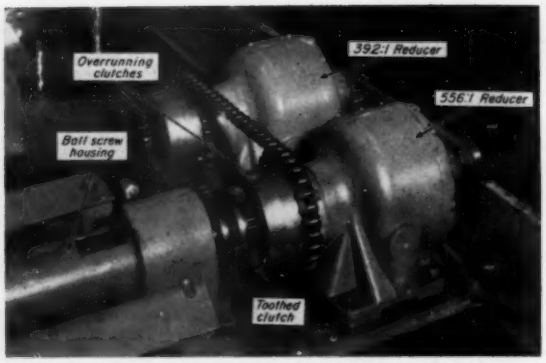
United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

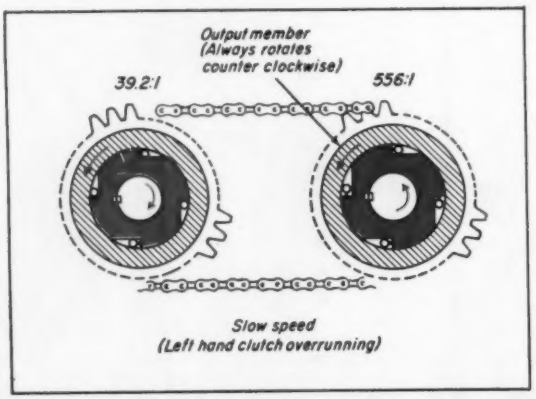
For more information circle No. 19 on the Reader Service Card



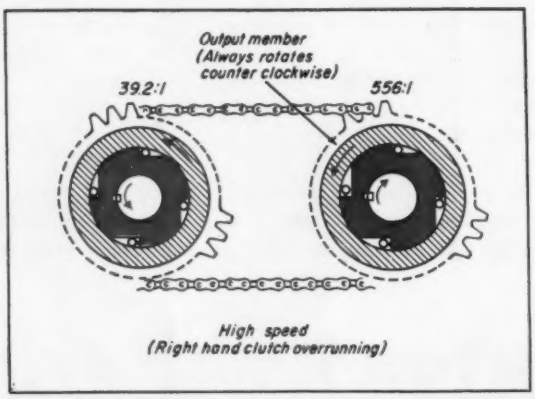


TWO SPEED REDUCERS driven by same hydraulic motor give fast speed range change when hydraulic motor is reversed. Speed reducer output connects to ball screw with toothed clutch.

Overrunning clutches perform dual-



SLOW SPEED RANGE is selected when output shaft of 39.2:1 reducer is turning clockwise and output shaft of 556:1 reducer turns counterclockwise. Clutch on the low-speed reducer shaft locks up to drive ball screw, sprockets, and driven member.



HIGH SPEED RANGE is selected when output shaft of 556:1 reducer is turning clockwise and output shaft of 39.2:1 reducer is turning counterclockwise.

REVERSING A HYDRAULIC MOTOR selects high or low speed range in the table drive of a band milling machine. Two speed reducers are driven by the hydraulic motor at the same speed and in the same direction. Output rotation of the speed reducer shafts is opposite so that the output shaft of one turns clockwise while the other turns counterclockwise.

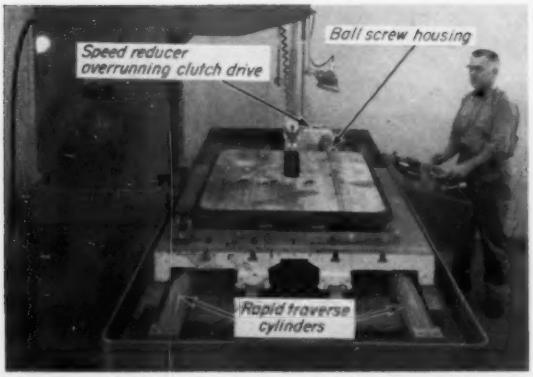
Output shafts of the two reducers are connected together by chain, sprocket, and overrunning clutches. Overrunning clutches assure that the output of the combination is always counterclockwise. The overrunning clutch serves as the only output for the combination. Thus, direction of input rotation determines which reducer actually drives. Speed is thus changed by reversing the drivemotor with a 4-way valve.

The speed reducers have ratios of 39.2:1 and 556:1. Speed of the 3-hp hydraulic motor is varied by a flow control valve to give table speeds of 0.030 to 0.800 and 0.306 to 12 in. per minute.

Output of the overrunning clutch connects to a ballscrew that drives the table. A toothed clutch connects the ball screw and overrunning clutch. This lets the table be moved in either direction by the hydraulic cylinder at speeds to 8 fpm. The clutch is operated by the hydraulic cylinder. Hydraulic valving assures that the toothed clutch disengages when hydraulic pressure is applied to the rapid traverse cylinder.

A strain gage senses pressure of the workpiece against the saw blade. This automatically stops feed to keep blade force below safe maximum value. Strain gage output is fed to an amplifier. Amplifier output at maximum force operates a relay. The relay has a set of normally-open contacts which close to operate a solenoid valve and shut off flow to the hydraulic motor. When feed force drops below the maximum, relay contacts reopen valve and let table feed continue.

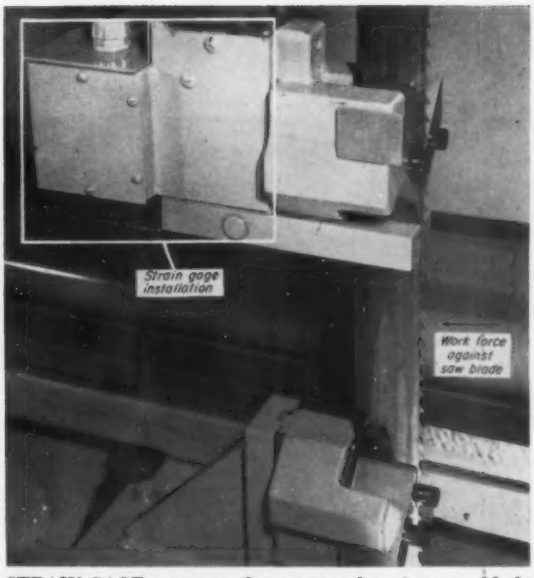
The band milling machine is made for *The Do-ALL Co.*, Des Plaines, Ill. ▲▲▲



Dual-range table drive is made up of hydraulic motor, overrunning clutches, toothed clutch, and ball screw.

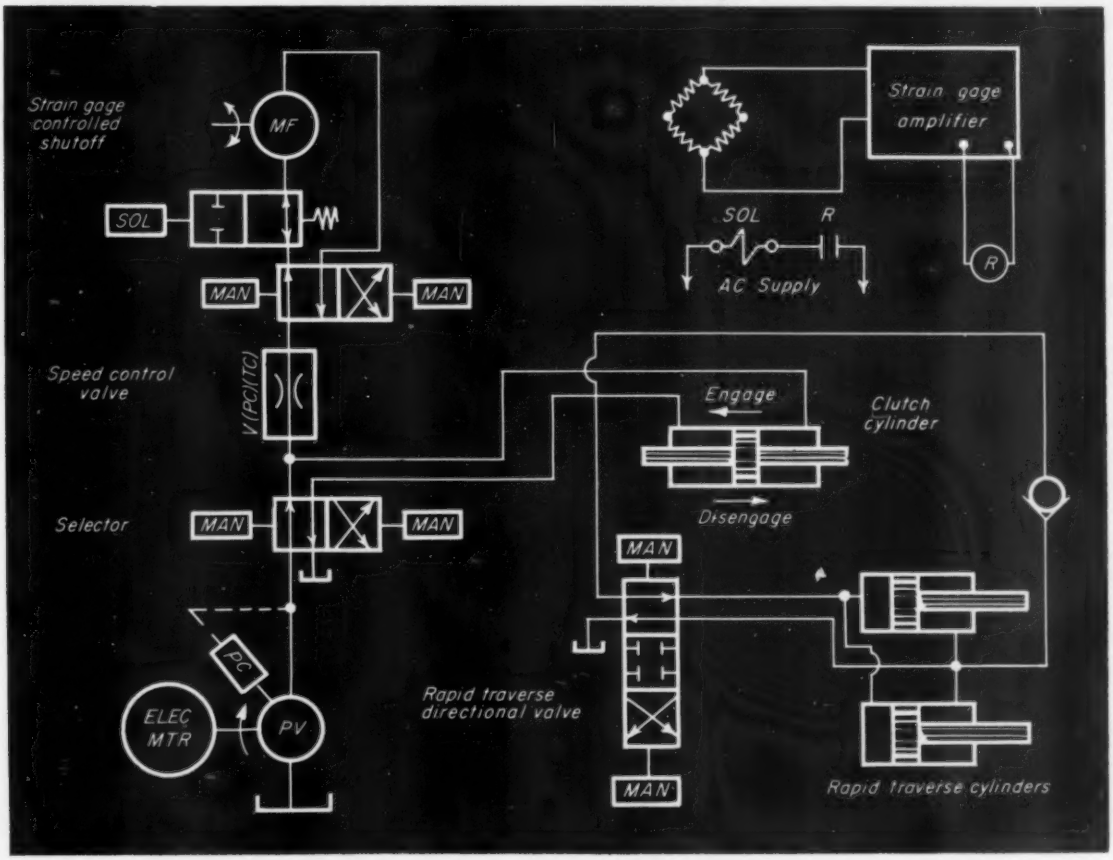
speed selection

By CHARLES E. CLELAND,
project engineer,
Continental Machines, Inc.



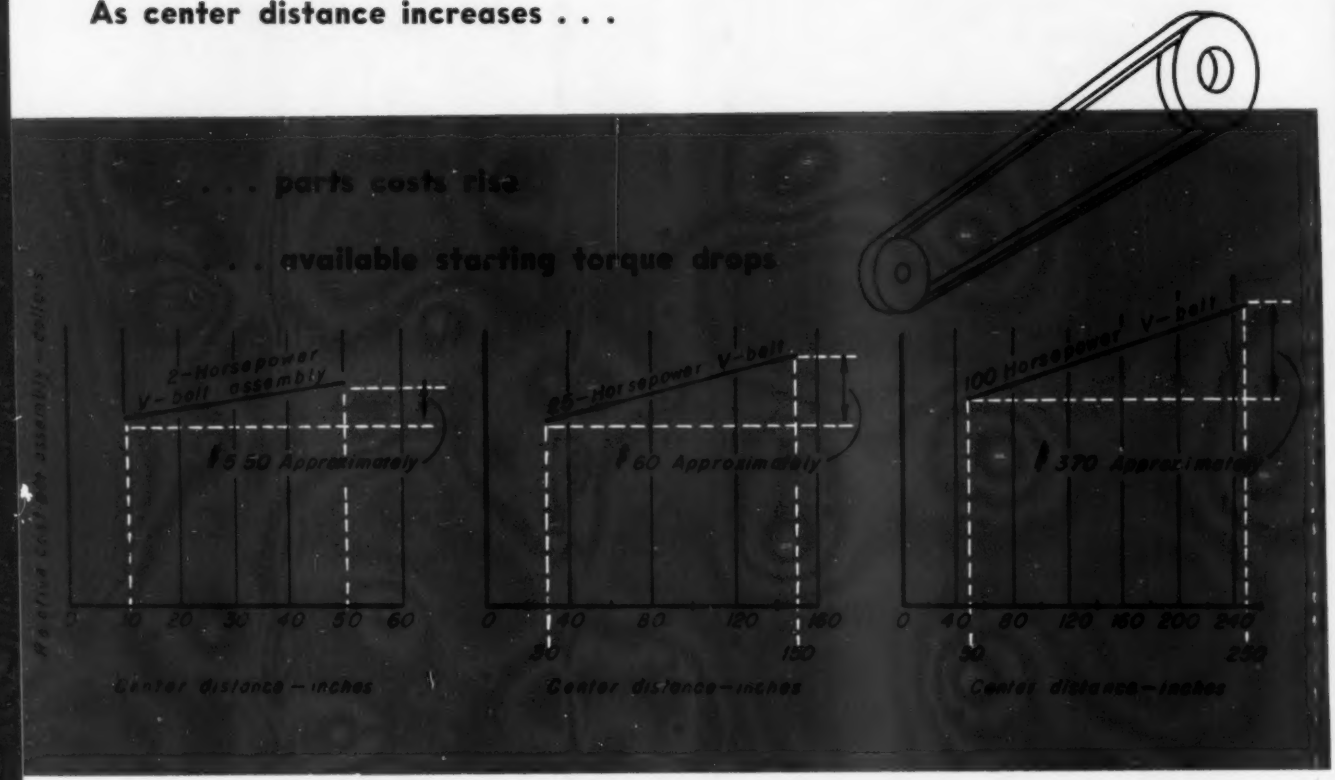
STRAIN GAGE measures force exerted against saw blade and shuts off feed motor when force gets too high.

HYDRAULIC, STRAIN GAGE CIRCUITS for the band milling machine feed. *Selector* starts hydraulic motor and engages the toothed clutch to drive the ball screw. Strain gage installation energizes solenoid to close shut-off valve and stops hydraulic motor if load on saw band is too high.



No. 1. For more information on any component in this article, see page 39

As center distance increases . . .



Keep your power source

By DANIEL BRANDT, *assistant professor, Milwaukee School of Engineering*

THREE UNDESIRABLE RESULTS of increasing center distance are higher cost, lower torque-horsepower output and loss of accuracy—also called increased backlash.

Dollars, horsepower and efficiency are drained daily because prime movers and work shafts are not kept as close together as possible. Beside the above losses and extra floor space needed, added hardware is used and the problem multiplies.

Some manufacturers subtract 4% power loss at every power transmission junction which includes gear meshes, chain and belt drives, universal joints and others. These losses are caused by rubbing, sliding, windage, and other types of rotating friction.

Cost Vs Center Distance

A long V-belt costs more than a short one. Increasing center distance increases cost of the whole assembly. The assembly includes the driving sheave, output sheave and belt itself. The curves above illustrate how cost increases with center distance.

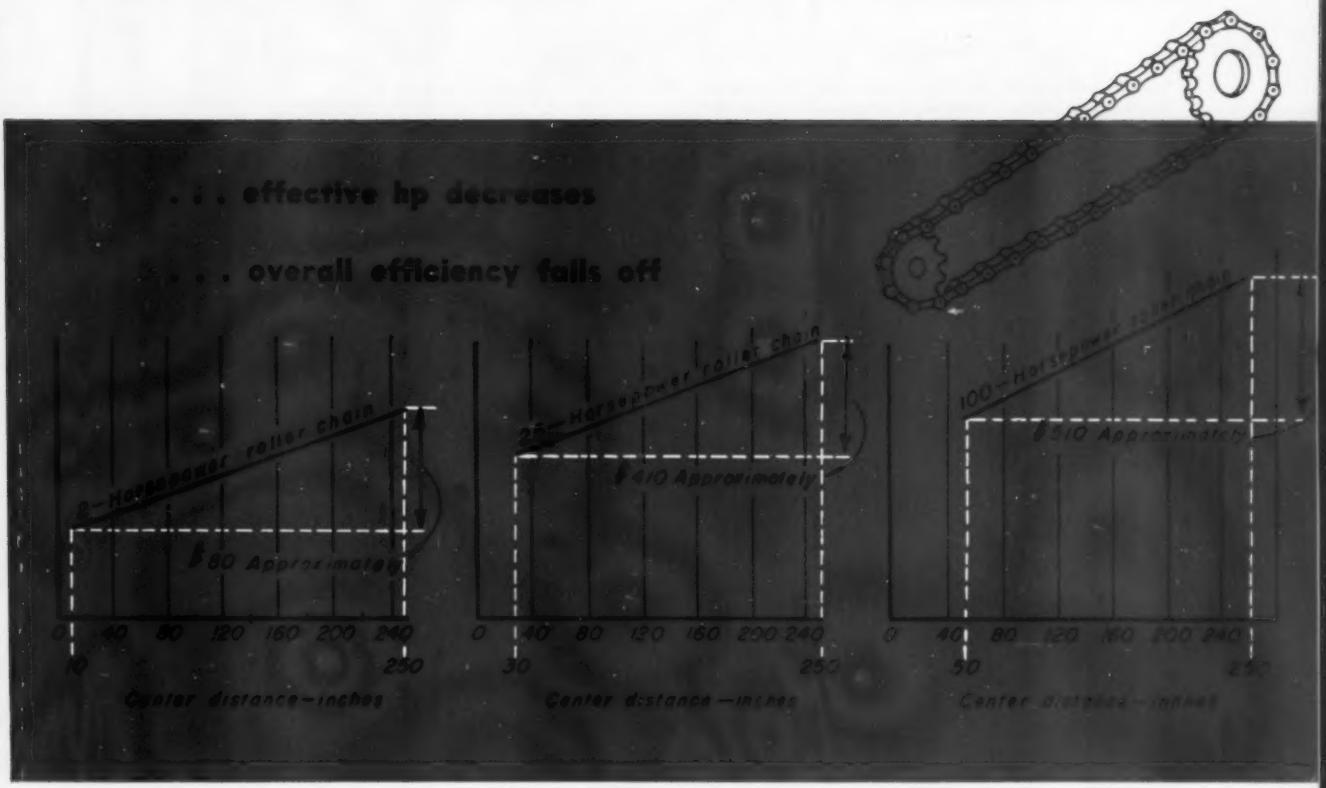
Since the cost of a belt is directly proportional to length, the curve becomes an almost straight-line. Cost and length are not exactly proportional to center distance, however, since belt-sheave angle changes as center distance increases.

The price differentials shown are based on horsepowers indicated and only one specific angular input and output velocity.

These values change as rpm changes.

The cost of roller chain also is based directly on length, thus making their curves also near straight-line functions. These curves are based only on the horsepower for the double strand chain, specific speeds, velocity ratios and pitches indicated.

For gears, increasing center distance usually results in increasing number of meshes rather than increasing gear diameters unless pitch diameters are not limited due to space. Since adding more gears means adding more dollars, the assembly might better be designed with a common drive shaft with bevel gears at both output and input ends.



close to your work

Torque and Hp Loss for Chain

The additional starting torque and horsepower caused by increased center distance of a roller chain drive may be calculated as follows:

$$T_i = \frac{5.65\ wnD^2L_i}{t} \times 10^{-6} \quad \text{.....(1)}$$

$$T_i = \frac{2.16\ wVDL_i}{t} \times 10^{-5} \quad \text{.....(2)}$$

$$hp_i = \frac{1.08\ wn^2D^2L_i}{t} \times 10^{-9} \quad \text{.....(3)}$$

$$hp_i = \frac{1.57\ wV^2L_i}{t} \times 10^{-8} \quad \text{.....(4)}$$

Where

D = pitch diameter of motor sprocket, inches
L_i = increased length of chain, feet
T_i = additional starting torque required, ft-lbs
V = linear velocity of roller chain, feet/minute
hp_i = additional starting hp required
n = angular velocity of motor sprocket, rpm
t = time in seconds desired to reach velocity V
w = weight of roller chain, lbs per ft

V-Belt Losses

Because of the ligher weight of V-belts, the increased torque and horsepower caused by center distance increase is not a major factor.

Continued on next page

Example

Find additional starting torque and horsepower required if center distance is increased 5 ft in the following chain drive:

80-2 double-strand roller chain, 1-inch pitch, and weight of 33 lbs per ft. Driving sprocket diameter is 6.71 in.; operating speed is 1110 rpm. Chain operating speed is 1950 feet per minute and it is desired to reach operating speed in 20 seconds.

Solution

Length increase is slightly less than double center distance increase which is approximately 10 ft. Therefore:

$$T_1 = \frac{5.65\ wn\ D^2L_1}{t}\ 10^{-6} =$$

$$\frac{(5.65)(33)(1110)(6.71)^2(10)(10)^{-6}}{20} = 4.66\ \text{ft-lb}$$

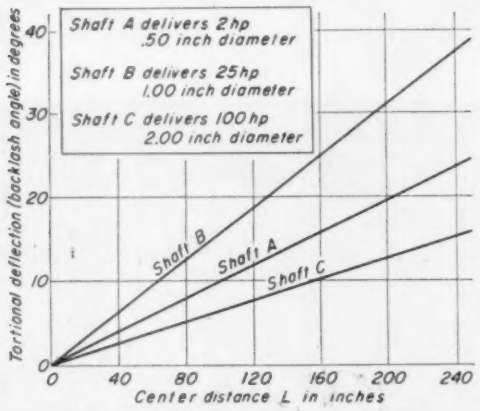
or

$$T_1 = \frac{2.16\ wVDL_1}{t}\ 10^{-5} =$$

$$\frac{(2.16)(33)(1950)(6.71)(10)(10)^{-5}}{20} = 4.66\ \text{ft-lb}$$

$$hp_1 = \frac{1.08\ wn^2D^2L_1}{t} \times 10^{-9} =$$

INCREASED CENTER DISTANCE = INCREASED BACKLASH



TORSIONAL DEFLECTION increases as shaft length.

$$\frac{(1.08)(33)(1110)^2(6.71)^2(10)(10)^{-9}}{20} = .986\ \text{hp}$$

$$hp_1 = \frac{1.57\ wV^2L_1}{t} \times 10^{-8} =$$

$$\frac{(1.08)(33)(1950)^2(10)(10)^{-8}}{20} = .986\ \text{hp}$$

The additional torque and horsepower required once speed is reached is usually negligible.

Continued on page 40

INCREASED CENTER DISTANCE = INCREASED BACKLASH

NUMBER OF GEAR MESHES	BACKLASH MEASURED AT INPUT SHAFT (INCHES)			
	VELOCITY RATIO – INPUT SHAFT RPM / OUTPUT SHAFT RPM			
	1/1	2/1	10/1	50/1
1 (Input, Output)	.001	.001	.001	.001
2 (Input, Output)	.00200	.00241	.00416	.00807
3 (Input, Output)	.00300	.00385	.00782	.01828
4 (Input, Output)	.00400	.00528	.01158	.02953

MRC PILLOW BLOCKS and FLANGE UNITS with *Labri-Seal® BALL BEARINGS

NEW MRC *Labri-Seals*®

combine the advantages of

- → **a rotating flinger**
- → **labyrinth seal**
- → **and positive contact synthetic rubber seal.**

Their efficiency in keeping grease in and dirt out has been proven in many environments involving extremes in dirt and moisture.

MRC *Labri-Seal*® ball bearings are pre-lubricated at assembly eliminating any need for further lubrication.

Write for FORM 1550-1

PERMANENTLY LUBRICATED
POSITIVELY LOCKING
SELF ALIGNING

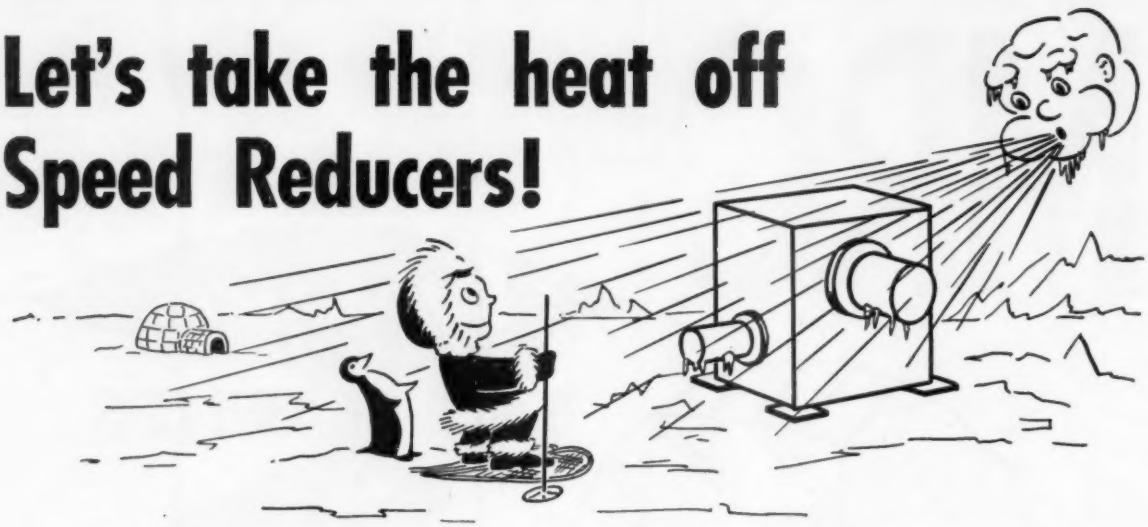
Write OUR Engineering Department regarding YOUR bearing problems

MARLIN-ROCKWELL CORPORATION
Executive Offices: **Jamestown, N.Y.**

MRC BALL AND ROLLER *bearings*

For more information circle No. 11 on the Reader Service Card

Let's take the heat off Speed Reducers!



A worm gear speed reducer is one of the toughest little customers in captivity. It reduces speeds day-in, day-out, with little complaint. While it works long and hard, it has limitations—set by ratio, center distance, RPM, mechanical and thermal HP ratings, etc. And, depending upon how precisely it was selected and fitted to the job requirements, it will do what it has to do.

But sometimes it's forced to play outside of its league. It must cope with job requirements that vary from here to there—normal 8 to 10 hour service without recurrent shock, the same length of service where there is some shock loading, continuous low-speed service and almost countless others. But the thing that really puts the pressure on reducers, the thing that's lurking in *every* set of job requirements—is h-e-a-t.

When you exceed the thermal capacity of a reducer for more than an hour or so, excessive temperature thins the lubricant resulting in wear; material, bearing and oil seal failures; etc. Of course, the proper lubricant will help but it can't cure the continuing problem of excessive heat.

So how can we lick this toughy? One way is to build the reducer housing oversize, big enough to radiate the heat away and keep temperatures down. But this type sticks out in aisles, louses up compact designs and barks shins. Then, we might try a smaller housing complete with fins on it to dissipate the heat. If this still doesn't work, another trick is to use a reducer with capacities and ratings a step above the ones we need. This is sending a man to do a boy's job. It's impractical, inefficient and costly. There *has* to be an easier, better, saner and cheaper way to do it. And there is!

In certain cases, where the size and type of reducer permits and where we can gain enough in thermal HP rating to keep heat generation in bounds, Cone-Drive Gears does it with fan-cooling.

What's that? Simple. Just add a fan to the worm shaft plus the necessary air shields, fan cover, etc., and presto!—heat is no longer a problem. The air shields direct the fan-pushed air over the fins on the lower portion of the reducer. The fins are shaped and spotted to guide the air stream where it is needed. Thermal HP ratings are boosted tremendously, as high as 147% above those of standard reducers in some cases! Those over-worked, over-heated reducers will now do the job you bought them to do.

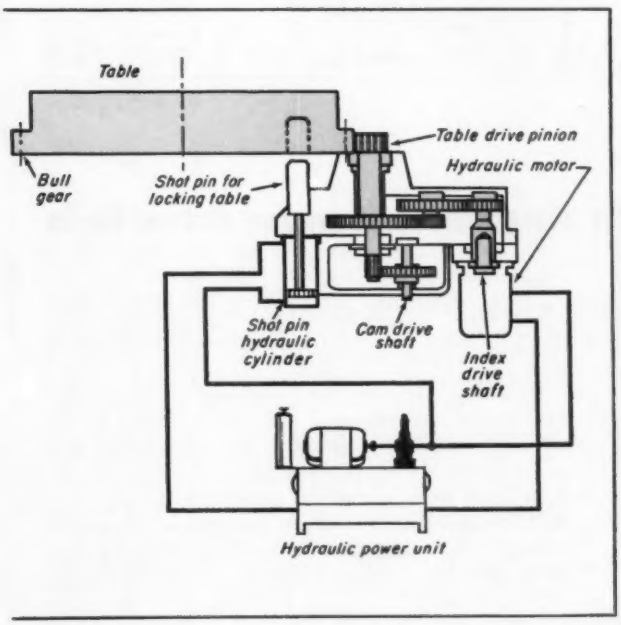
Other advantages? They're here in abundance. The size of the reducer stays the same. All parts on a Cone-Drive fan-cooled reducer are 100% interchangeable with parts for standard reducers. Oil capacity is identical. Shields are quickly removed without disconnecting the reducer. (This is important where severe operating conditions make periodic cleaning necessary). The reducer can also be operated *without* fan-cooling just by taking off the fan and shields.

This simple addition to standard Cone-Drive HU speed reducers might be just your answer—might save you some money. Write for Cone-Drive's Bulletin CD-218. It will tell you all about the full line of Cone-Drive double-enveloping worm gear reducers as well as the fan-cooled kind. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

For more information circle No. 4 on Reader Service Card

IDEAS
FROM THE FIELD

Hydro-mechanical drive smoothly slows large mass



REDUCTION GEARING driven by hydraulic motor gives smooth controlled speed and deceleration of large indexing table.

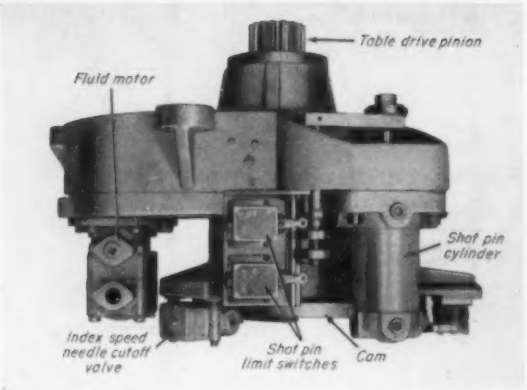
SHOCKLESS deceleration of a heavy rotary table on a machine tool is gotten from a hydraulic motor driving through reduction gears. The gearing lets the motor turn through 234 revolutions for every 1 revolution of the table. Acceleration and deceleration of the table are controlled by controlling oil flow to the motor.

A cam, driven off the reduction gear train turns one revolution for each revolution of the table. Cam works a shutoff valve which, with several solenoid-operated valves, controls indexing. Fluid for operating the hydraulic motor is supplied by a pump that operates one of the machining units.

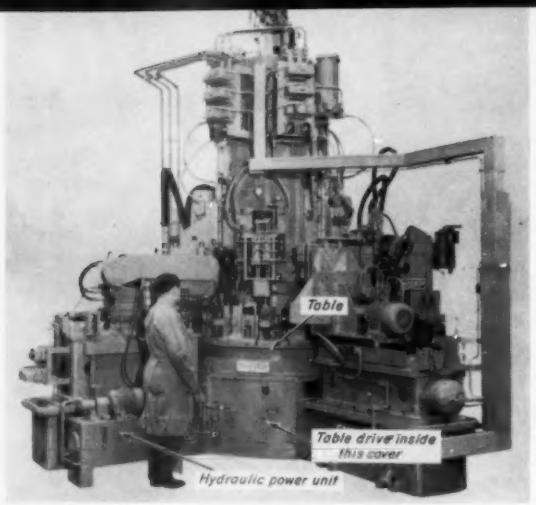
The index sequence starts with energization of the shot pin *Disengage* solenoid. This retracts the shot pin which locks table in position. When shot pin cylinder is fully retracted it operates a limit switch to energize the *Index* and *Index start* solenoids. This directs fluid to the hydraulic motor and connects the other side of the motor directly to tank so acceleration will be rapid.

As soon as the cam driven by the motor opens the *Index speed needle cutoff* valve, the *Index start* solenoid is de-energized and the *Decelerate* solenoid is energized. This means that oil from the outlet of the hydraulic motor must pass through the *Decelerating* and *Index speed* needle valves. Valves restrict oil flow

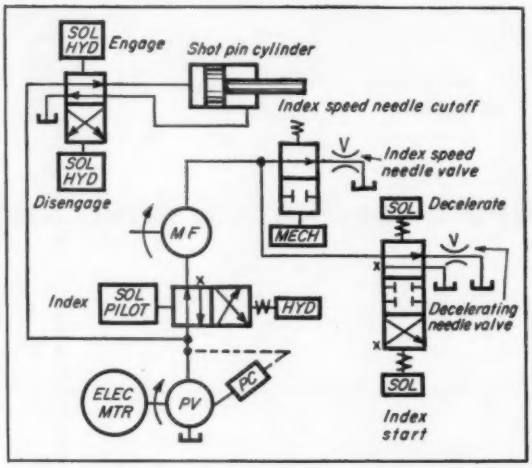
Continued on next page



FLUID MOTOR and gear reduction unit drive indexing table through large bull gear attached to table. Shot pin cylinder extends and retracts pin which locks table in position, when extended.



INDEX DRIVE UNIT is underneath table of large center-column type machine tool.



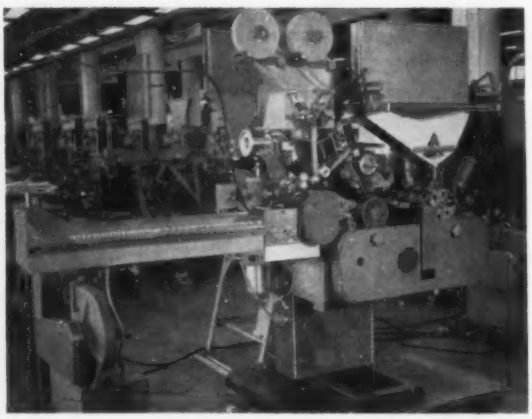
HYDRAULIC CIRCUIT DIAGRAM for table indexing system.

and limit table speed. As the table nears the end of the index, the cam closes the *Index speed needle cutoff*. Oil from the motor then goes through the *Decelerating* needle valve, to decelerate the table.

When correct position is reached, the *Index* solenoid drops out to stop the hydraulic motor and the *Engage* solenoid is energized to extend the shot pin and lock the table in position.

This system was designed by engineers at *Snyder Corp.*, Detroit, Mich., for use on center-column type special machine tools.

Overrunning clutch prevents shutdown if main drive fails

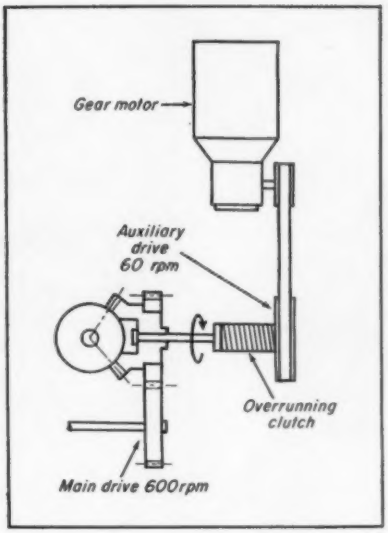


AUXILIARY DRIVE for this filter tip attaching machine runs constantly, but drives through an overrunning clutch only when the main drive is stopped.

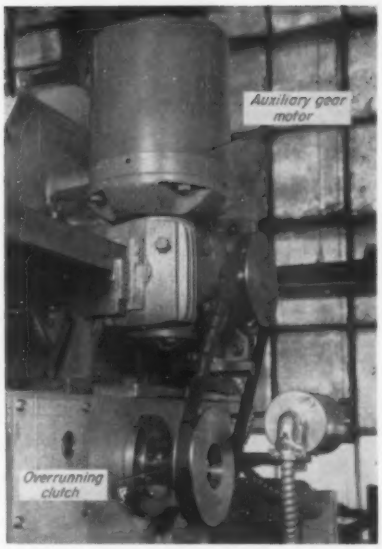
AN OVERRUNNING CLUTCH lets an auxiliary drive take over machine operation anytime the main drive stops.

Machine driven by the low-power drive attaches filter tips to cigarettes and is normally driven by the main drive directly ahead of it. The main drive operates at 600 rpm and overrides the auxiliary unit. If the main drive shuts down, the auxiliary drive operates the filter tipper at 60 rpm and prevents drying out of adhesives and clogging of the machine. Also, the auxiliary drive lets a run of cigarettes be tipped without

SECTION through the auxiliary drive.



AUXILIARY GEARMOTOR mounted on the side of the machine drives through sheaves, V-belt, and overrunning clutch.



having to run the entire line when only the tipping operation remains to be done.

Auxiliary drive is a vertical, right-angle, ⅓-hp gearmotor which drives the input shaft through sheaves, a V-belt and spring-type overrunning clutch. When the main drive is operating, the clutch spring tends to unwind and does not, therefore, drive. When the main drive is disconnected, the spring winds up, grasps the driven member, and drives the machine.

American Machine & Foundry Co., Brooklyn, N. Y., makes the tipper and the cigarette-making machine.

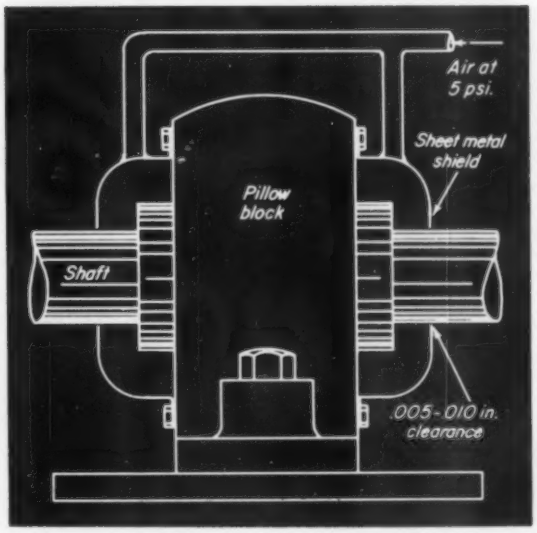
Air shield on pillow block prevents abrasive damage

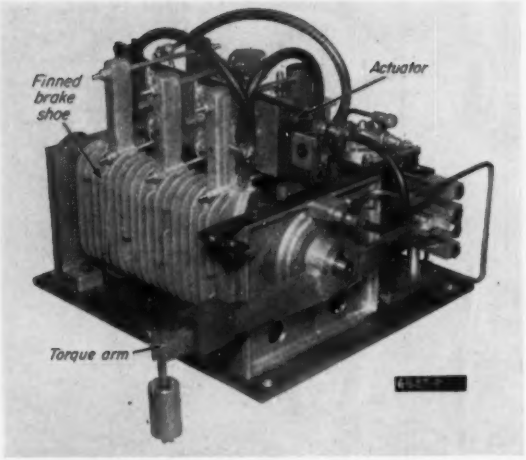
Sheet metal housings on each side of pillow blocks prolong life of bearings in an abrasive manufacturing plant. Low pressure air is piped into the housings to assure that no grit gets into the bearings.

Clearance between the housings and the shaft is from 0.005 to 0.010 in. Air is supplied from the plant air supply at 5 psi. This pressure is used to give minimum air consumption with positive pressurization.

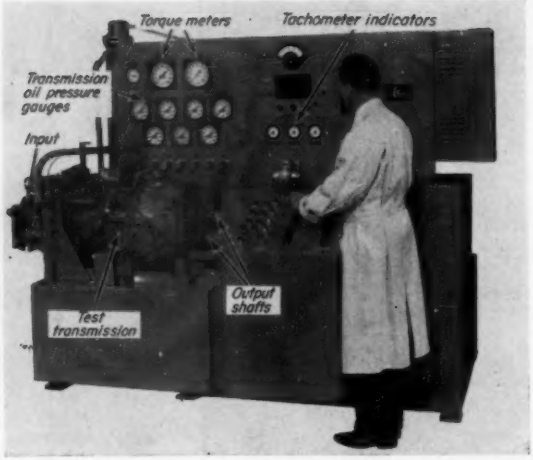
It was felt that a lower pressure might not be enough when the bearings were cooling during *off* periods. It is during *off* periods that a bearing is most subject to contamination, since pressure is then lower than atmospheric due to contraction.

Air is filtered to keep contaminants in the air from harming the bearing by a combination filter and pressure regulator. Before this idea was used in the *Carborundum Co.'s* Niagara Falls, N. Y. plant, bearings and seals had to be replaced twice a year. None have had to be replaced since the system was installed in 1955.



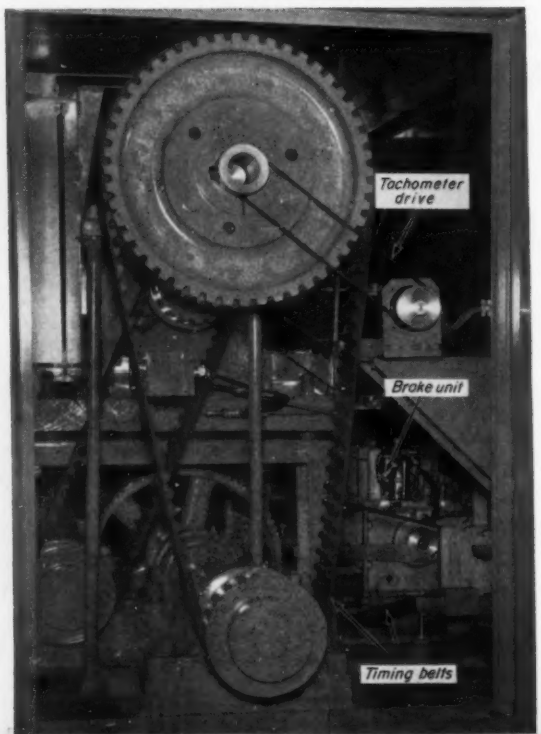


AIR-OPERATED PRONY BRAKE applies torque proportional to air pressure on actuator. Brake shoes are both water-cooled and finned.



TRANSMISSION TESTER shows shaft speeds, output torques, and oil pressure. Rig tests for noise and proper shift points.

Pneumatic brakes give precise torque control



AIR-OPERATED BRAKES let several preset torques be applied to the output shafts of an automatic transmission during tests. The loads applied are equal in magnitude to those met in service. This lets the transmission be checked for noise and also checked to see that automatic shifts are made at the proper time.

Two brakes are used, one on the main output shaft and one on the power-take-off shaft. To decrease torque required of the brakes, step-up timing belt drives connect them to the shafts. Brake drum speeds are as high as 8000 rpm. Torque is determined by air pressure applied to a rubber bag actuator which forces the brake shoes against the drum. Brake is the external-contracting type.

Three preset pressure regulators determine torques applied. Push-button operated control valves select required torque. Force-feedback from the torque arm keeps torque setting constant regardless of input speed. Torque is indicated directly on a specially-calibrated air-pressure gage.

The stand also measures speeds of input and output shafts and automatically fills and drains the transmission lubricant at the beginning and end of the test.

The tester is made by *George L. Nankervis Co.*, Detroit, Mich., for testing a Ford Motor Co. 10-speed hydraulic transmission for truck use.

BRAKE TORQUE REQUIREMENT is decreased by using step-up timing belt drives from transmission output shafts to brake input. Drive belt for tachometer generator is an O-ring.

Announcing Worthington QD Sheaves with the

GOLDEN SCREWS

To demonstrate to you that the exclusive two-screw design is practically worth its weight in gold, all Worthington QD (Quick Detachable) sheaves now have two golden screws.

The clamp screw simplifies installation and assures permanent alignment. You can install QD sheaves one part at a time. No heavy rim and hub combination to delicately inch into place. You just slide the hub on the shaft and permanently lock it in position with the clamp screw. Then you slide the sheave rim into position on the hub. This job is simplified because you engage the large end of the sheave with the small end of the hub. To change speed you simply install another sheave on the hub which remains anchored to the shaft by the clamp screw.

The set screw prevents "key drift." It locks the key securely in place, avoiding the danger of the key drifting off and becoming a safety hazard. This feature is appreciated by plant operators who first brought this potential danger to Worthington's attention.

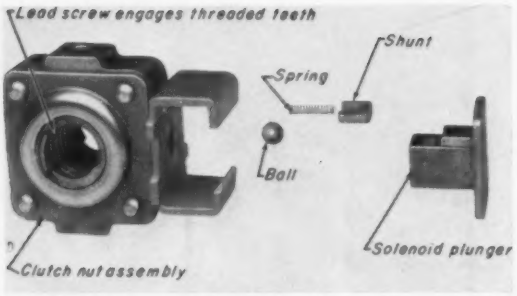
You tighten the set screw without distorting the hub. The clamp screw allows you to locate the hub on the shaft. The locked hub then permits you to tighten set screw on key without distortion.

You can get Worthington QD sheaves anywhere in the U.S. More than 350 distributors carry Worthington sheaves and Worthington-Goodyear Green Seal V-belts. For your copy of a 100-page Multi-V-Drive Manual on how to select the right sheave and V-belt write to Worthington Corporation, Section 79-15, Oil City, Pennsylvania. In Canada: Worthington (Canada) Ltd., Brantford, Ontario.

WORTHINGTON

For more information circle No. 21 on the Reader Service Card

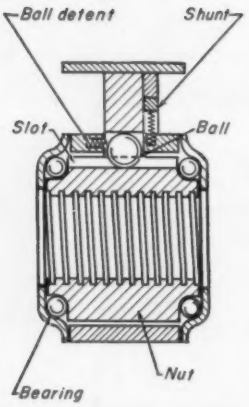
Clutch-nuts on single shaft do multiple driving functions



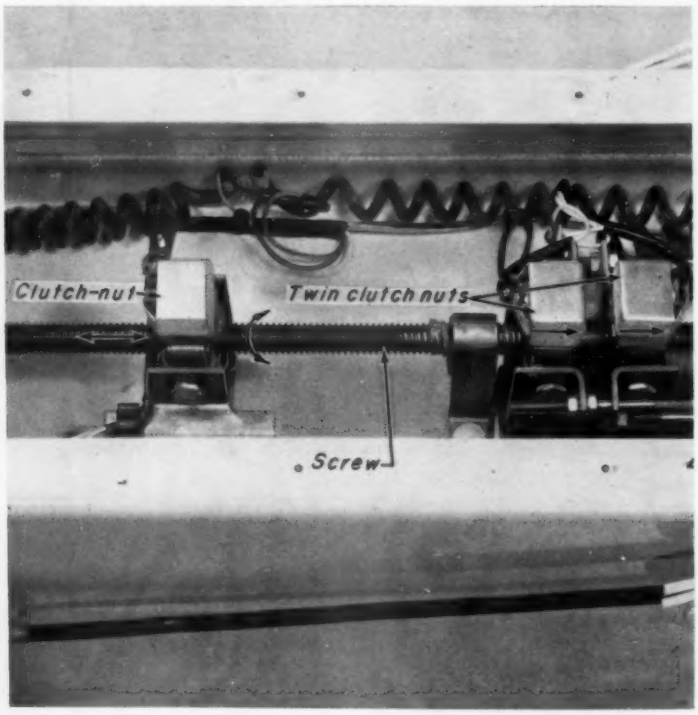
CLUTCH-NUT partly disassembled shows solenoid plunger, magnetic shunt, shunt return spring, and ball for engaging the nut with the body.

SEVERAL CLUTCH-NUTS transmit power from a single rotating screw in the drive system of a powered hospital bed. Because each nut has its own clutch to engage or disengage independently from the screw, different actions can be driven by the single screw and motor.

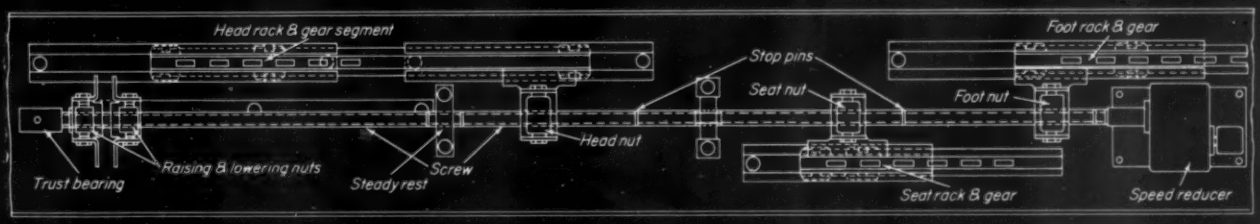
Threaded portion of the clutch-nut serves as the inner race for two angular-contact ball bearings which reduce friction. Outer races for the bearings are two pressed steel covers riveted to the sides of the nut housing. Clutching is performed by a solenoid plunger forcing a ball into a slot in the outer surface of the nut to prevent the nut from rotating with the screw and not travelling along the screw.



CUTAWAY VIEW of clutch-nut shows bearings, locking ball, clutching groove in the nut, and magnetic shunt.



INSTALLED VIEW of three of the nuts and the screw which power the hospital bed. The twin clutch nuts give enough force to raise the entire bed through a cable system.

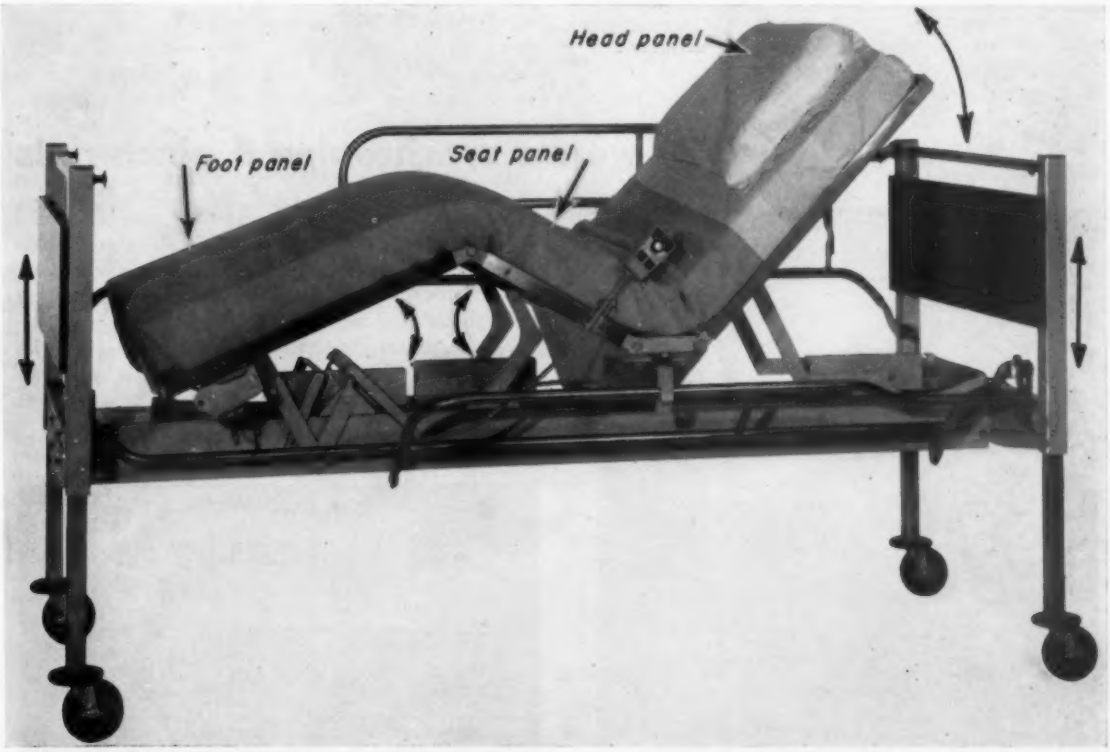


FIVE CLUTCH-NUTS driven by the same motor and speed reducer power all motions on a hospital bed.

The clutch nut assembly also includes an automatic overload release. Slot in the outer surface of the nut is shaped so as to cam the ball out of the slot when torque becomes excessive. The ball is held out by a small detent spring. A magnetic shunt keeps the solenoid from forcing the ball back into the slot even though current is still applied to the solenoid coil. This magnetic shunt is a small piece of steel which short circuits the magnetic flux so it cannot pull in the solenoid plunger. A small spring returns the shunt to its original position when the voltage applied to the solenoid coil is interrupted. This feature prevents the clicking noise which would occur on each revolution as the ball came out of the slot if it were not held out. It also eliminates the need for limit switches to de-energize the solenoid when the nut reaches its travel limit.

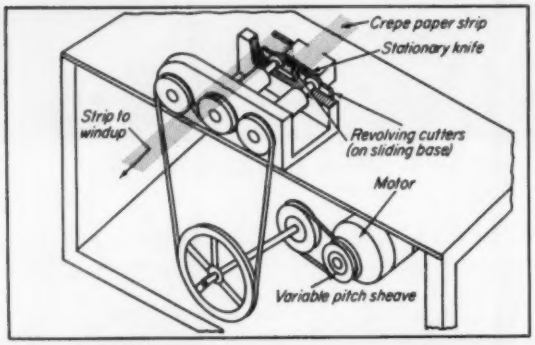
On the hospital bed, five of these nuts are used to raise and lower the head, seat and foot sections, and to raise and lower the entire mattress supporting structure as a unit. All are driven by a single screw, motor and speed reducer. Limit of travel for each nut is established by putting a pin through the screw at the required position. Motion of the nut is transmitted to the portion of the bed to be moved by gear segments and racks or through cables and pulleys.

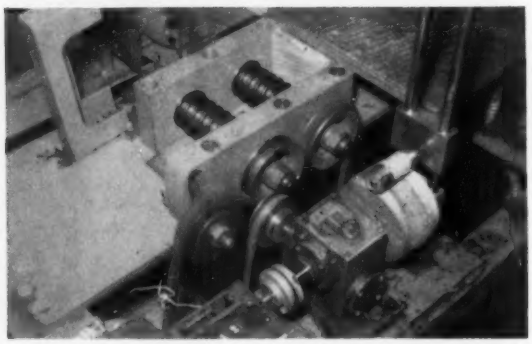
The clutch-nuts and bed were designed by engineers at *American Metal Products Co., Detroit, Mich.*



HOSPITAL BED panels are adjusted by racks and gear segments driven by clutch-nuts. The whole unit may be raised and lowered on telescoping legs by two clutch-nuts working through cables and pulleys.

Double-sided V-belt drives contrarotating cutters





CONTRAROTATING SHAFTS driven by a single, double-sided V-belt cut fringes on both sides of crepe paper strips. This lets a single stationary knife and two revolving knives be used simultaneously. The cutting stroke of the revolving knives is downward. If the knives revolved in opposite directions one would be going down and the other going up as they cut through the paper.

The V-belt goes over the top of one of the two adjacent sheaves and under the other and drives the shafts on which the knives are mounted. A third sheave holds the belt in contact with the sheaves where the belt goes underneath.

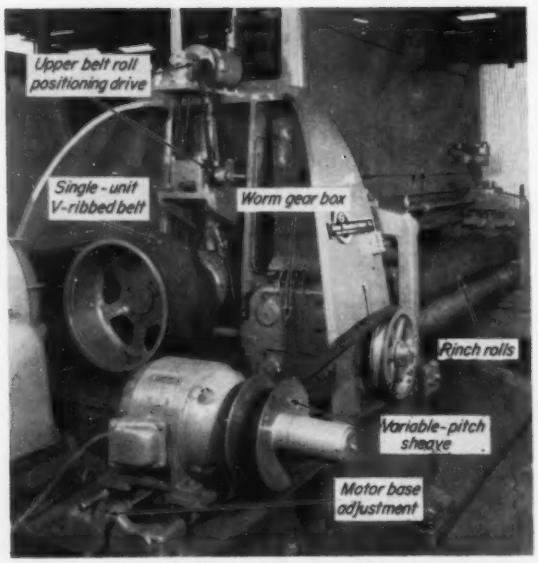
Fringe spacing can be varied by varying speed at which the knives are driven while keeping the transport speed of the crepe paper strips the same. A sliding motor base and variable-pitch sheave do this.

Dennison Mfg. Co., Framingham, Mass. built and uses this machine.

PERSPECTIVE OF FRINGER shows double-sided V-belt arrangement and the rest of the drive.

CLOSEUP OF KNIFE DRIVE PULLEYS on the crepe paper fringer.

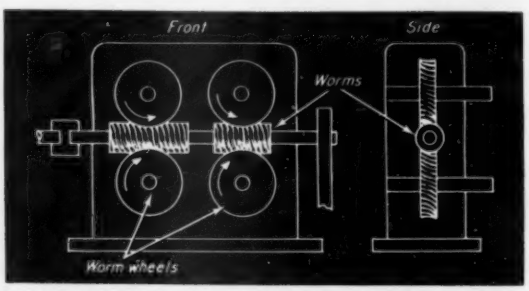
Four worms synchronize 8 pinch rolls



CLOSEUP OF DRIVE SIDE of machine shows pinch roll drive and upper belt roll positioning drive.

A single V-belt drive powers two gear boxes and eight pinch rolls on an abrasive-belt, flat sheet polishing machine. Each gear box powers four closely spaced rolls to control speed of the metal sheet passing through the machine.

The gearboxes connect to the pinch roll shafts with ball-and-trunnion type universal joints. The universals allow for endwise movement of the shafts as well as changes in angularity.



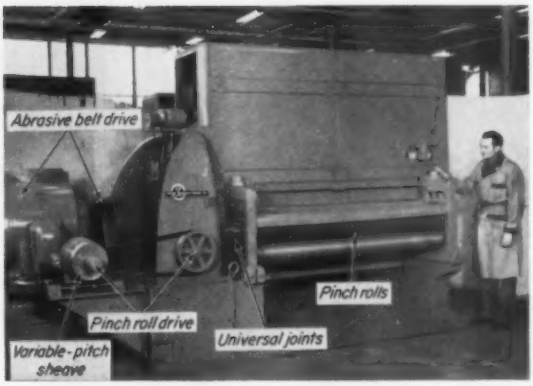
TWO WORMS on a single shaft drive four worm wheels to give a compact drive for the pinch rolls.

The machine has two sets of four pinch rolls. The worm shaft of one drives the other through the connecting line shaft. Speeds of all eight rolls are thus always in synchronization. A variable-speed sheave on the drive motor lets speed of all eight be varied simultaneously.

The pinch roll drive is independent of the abrasive belt drive. This lets speeds of the belt and sheet be changed during cutting or polishing. The abrasive belt is driven by a 150-hp motor through a single unit, V-ribbed belt and multiple-groove sheaves. This type of belt is used because it saves approximately 33 percent of the width of a multiple V-belt drive.

A separate drive is used to tension the abrasive belt. It consists of a small gearmotor that drives a vertical screw for moving the upper roll up or down. Power is transmitted from the gearmotor to the screw through chain, sprockets and a right-angle gearset.

The abrasive finishing machine was designed and built by *Acme Mfg. Co.*, Detroit, Mich.



SEPARATE DRIVE for the abrasive belt lets relative speeds of belt and sheet be varied. Ball-and-trunnion type universal joints permit changes in angularity of worm gear box and pinch roll shafts as well as endwise movement.

No. 2. For more information on any component in this article, see page 39

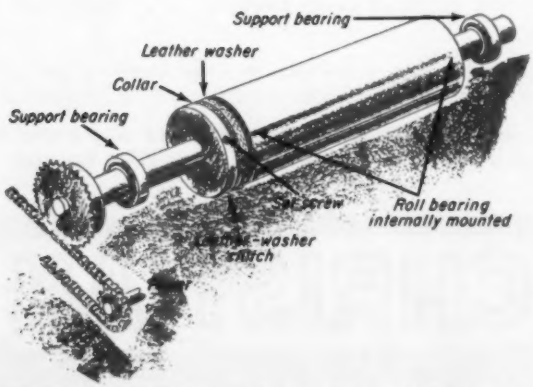
Leather-faced clutches transmit power smoothly

ROLLER CHAIN—55 feet of it and 27 sprockets replace a leader belt in a color print-making machine. A leader belt is a cloth belt that draws the web of printing paper through the machine from starting to the takeup roll. Previously, only the takeup roll was driven with this setup and the tension required to draw the paper through the machine at 24 in. per min was too much for the wet paper.

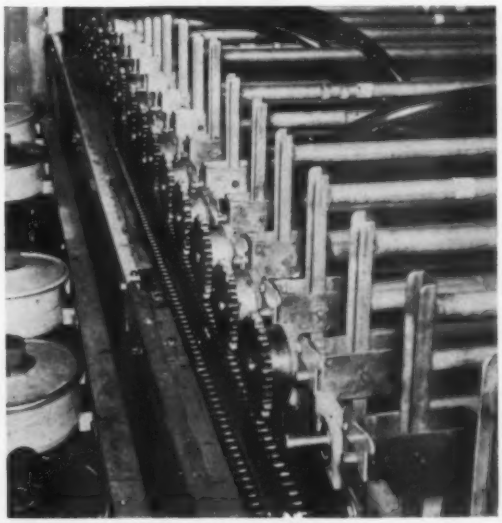
By powering all the previously idling guide rollers above solution level, the problem was solved. Small leather-faced clutches adjust the maximum power fed to each roll. Clutches are adjusted by trial and error. They consist of stainless steel collars which transmit their rotation through a friction facing that is a simple leather washer to the roller.

The long span of chain, 27 ft, is supported at various points since construction of the machine makes it easier to run the chain along the bottoms of the sprockets. Small angle brackets, spaced at about 2-ft intervals do this job.

This improvement was developed by plant engineers of *Berkey Photo Service, Inc.*, New York, N. Y.

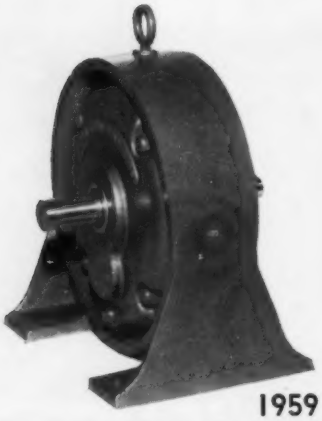


SIMPLE CLUTCHES on each roller let maximum torque transmission be regulated.

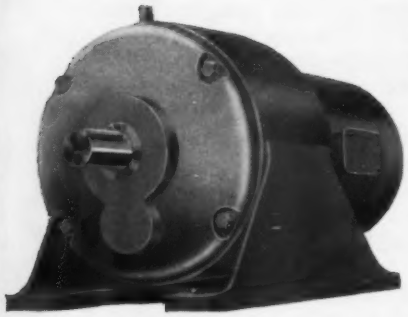


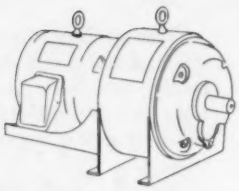
SPROCKETS AND ROLLER CHAIN let tension in color printing paper be reduced and tearing eliminated.

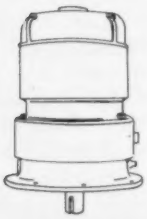
No. 3. For more information on any component in this article, see page 39



1959

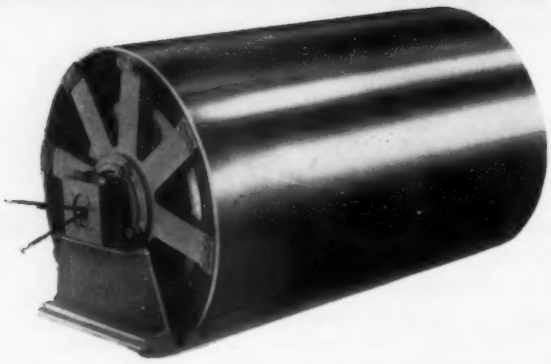






1929

1939



1949

GOOD THINGS COME IN SMALL PACKAGES

. . . though sometimes "the bigger the better." Either way, we have been designing and building gear "packages" for 35 years. The ones shown here are good examples of some of the units we originated. In order, TORK-FOOT Rite-Lo-Speed Reducer (1/2 to 400 HP), RITE-LO-SPEED Gearmotor (1 to 300 HP), AMERICAN* Reduction Drive (1 to 40 HP), and P.P.T. (1 to 50 HP)—our self-contained, packaged power terminal . . . . . (motorized head pulley).

Coming reasonably soon, a new gear package identified now only as Project X-59.

Industry looks to CHRISTIAN to pioneer the best in gear packages. Have you looked lately to see what CHRISTIAN can do for you?

*Mfg'd under license by American Pulley Co.

CHRISTIAN

J. D. CHRISTIAN • ENGINEERS
480 PORTERO AVENUE
SAN FRANCISCO 10, CALIF., U. S. A.

For More Information Circle No. 23 on Reader Service Card.

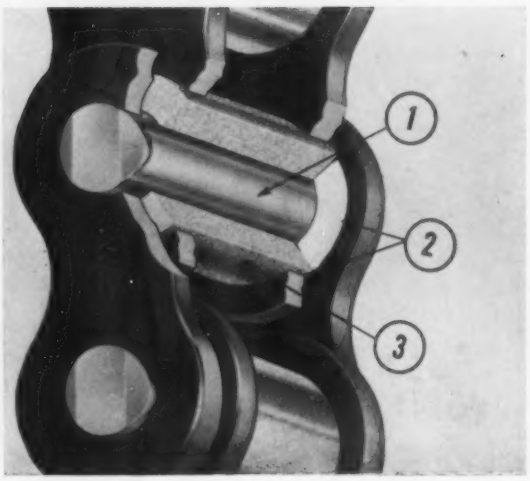
NEW PRODUCTS

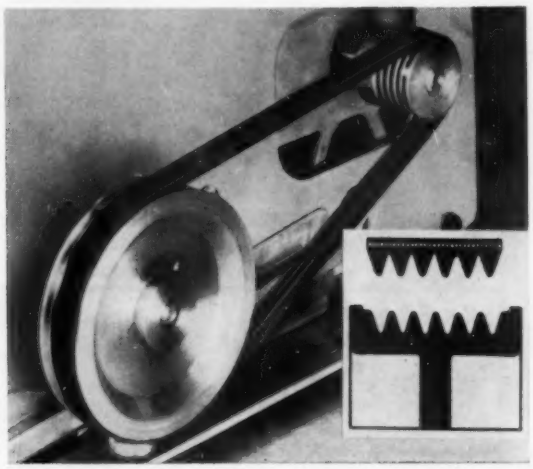
Self-lubricated chain

Faulty chain lubrication, cause of many drive problems, is overcome with new oil-impregnated, sintered steel bushings which provide lifetime lubrication for MSL (maximum service life) chain. Pressure and heat cause built-in lubricant to expand and flow from bushings, providing a constant supply to every working part of the chain. When drive stops, bushings reabsorb oil so there is no over-supply or wastage. Five times longer life is claimed. As shown at right, oil film minimizes wear between pin and bushing (area 1); oil-giving bushings extend beyond surface of inside plates to act as lubricated thrust bearings (area 2); exterior surface of bushings provides constant lubricating between sprocket teeth and chain, for smooth sprocket engagement. No rollers required. Chain is available in all standard essential dimensions.

Whitney Chain Co., Hartford, Conn.

Circle number 100 on reader service card





Versatile light-duty V-belts

Poly-V J belts are designed for high-speed, small-pulley power transmission applications. They are thin and flexible, and can operate over sheaves as small as 0.8 in. pitch diameter. Pitch lengths range from 8 to 98 in. Economy of belt width is attained with a single, endless rubber belt with a series of parallel V-ribs molded lengthwise around the inside circumference. Sheave grooves are designed to mate with belt ribs, and the load is evenly distributed across the full width of the drive member. Poly-V J belts work best at high speeds (10,000 rpm), and have been used successfully in home and workshop appliances, office equipment, fans, chain saws, pumps, garden and farm power implements, light industrial equipment and power tools.

Raybestos-Manhattan, Inc., Manhattan Rubber Div., Passaic, N. J.

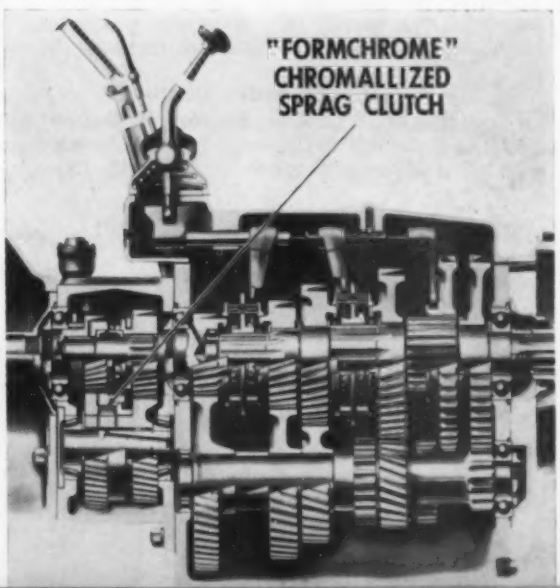
Circle number 101 on reader service card

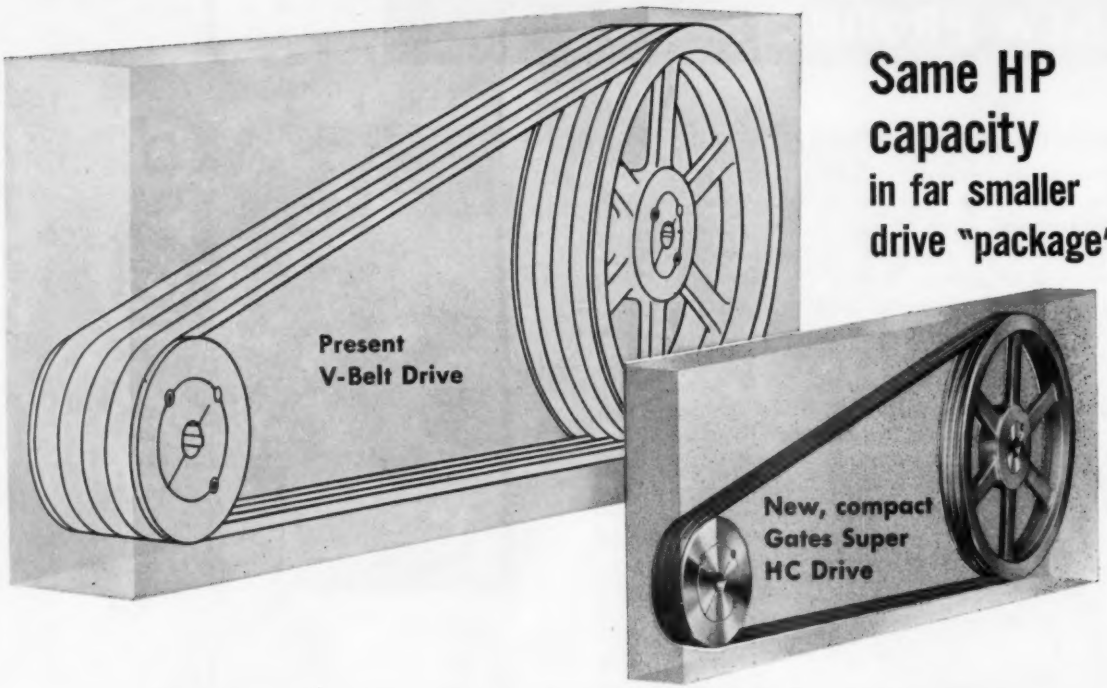
Long-life overrunning clutches

Formchrome is a chromallizing process of high-temperature diffusion alloying of chromium and carbon steel. The resulting surface has a hardness like tungsten carbides. This assures sprags having highest wear qualities; extreme resistance to abrasion and corrosion; no chipping, cracking or flaking of surface alloy; and unusual strength characteristics throughout the entire cross-section. At right is a cross-sectional view of a transmission with the Formchrome sprag clutch. 60 of these transmissions have been operating for 6 to 12 months, averaging 40,000 to 60,000 miles, with finest results, according to the manufacturer.

Formsprag Co., Warren, Mich.

Circle number 102 on reader service card





Same HP capacity in far smaller drive "package"

New high capacity Gates V-Belt cuts drive space, weight and cost

Reduce size, cut costs! Gates new Super HC V-Belt puts power transmission in a smaller package—cuts costs all along the line!

Actually, this major advance in power transmission—a development of *specialized* research in the world's largest V-belt laboratories at Gates—makes possible the most compact, lightest-weight, lowest-cost multiple V-belt drive you can put on any machine. Sheave diameters can be reduced up to 50%, sheave widths 30% to 50%, center distances 20% and more.

Reduce drive cost as much as 20%

On new drives, the cost of a Gates Super HC V-Belt Drive is as much as 20% under the cost of present V-belt drives of the same hp capacity. Furthermore, smaller housings and bases—less materials, production time, shipping costs all reduce costs still further.

Learn more about the cost-saving Super HC Drive

"The Modern Way to Design Multiple V-Belt Drives" is an informative handbook on the Super HC Drive, available from your nearby Gates Distributor listed in the Yellow Pages under Belts or Belting.

The Super HC V-Belt

transmits same HP in much less space than belts now in use

Shown below are space savings of a typical installation:

	Drive R Sheave Diam.	Drive N Sheave Diam.	Center Distance	No. of Belts
Present Drive	7.4"	20.0"	42.9"	4
Super HC Drive	5.3"	14.0"	30.0"	3

TPA 423

Gates

World's Largest Maker of V-Belts

The Gates Rubber Company • Denver, Colorado
Gates Rubber of Canada Ltd., Brantford, Ontario

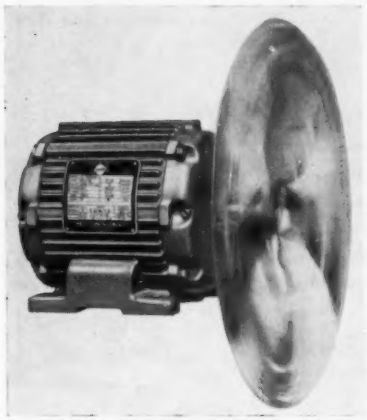
Gates Super HC V-Belt Drives

For more information circle No. 9 on the Reader Service Card

Continued from page 33

New fan motor

Air-Over fan motors, rated from 1 to 125 hp, are designed for quiet operation in ventilating systems, exhaust systems, cooling towers and other moving-air installations where motor drives a propeller or axial flow fan. Motor design makes use of air circulated to cool motor itself, so that maximum hp can be obtained from minimum motor size. Individual



motor nameplates indicate 3 hp ratings (nominal, operating and maximum) that can be achieved by varying air velocity across given motor. Foot or flange mountings, vertical or horizontal.

Louis Allis Co., Milwaukee, Wisc.

Circle number 103 on reader service card

Small gearmotor

Centrifugally governed three-speed gearmotor, 24v d-c, is rated at .1 hp at 1920, 1440 and 960 rpm. It is totally enclosed and explosion-proof, designed for 500 hour life and built to meet military specifications for

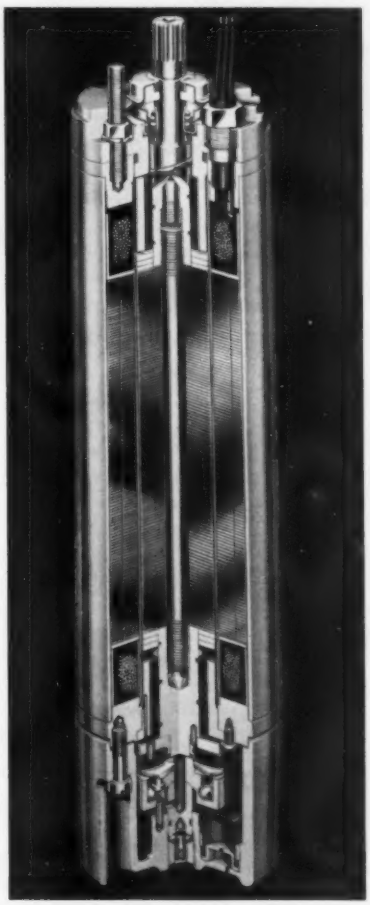
camera and tape applications. 6½ in. long, 2-5/16 in. diameter.

Western Gear Corp., Electro Products Div., Pasadena, Calif.

Circle number 104 on reader service card

Submersible motor

Only 4 in. dia, new motor develops 1½ to 5 hp single-phase, or 1½ to 7½ hp three-phase at 3550 rpm. It is designed to drive deep well turbine pumps in domestic and industrial water supply applications. Out-



side wound stator permits most effective use of copper and iron for high efficiency and torques. Stator is protected by high dielectric insulation system, is encapsulated in chemically inert plastisol and is sealed in stainless steel. Shaft height is adjustable to center pump impellers for optimum efficiency. All parts are corrosion resistant.

Louis Allis Co., Milwaukee, Wisc.

Circle number 105 on reader service card

Precision limit switches

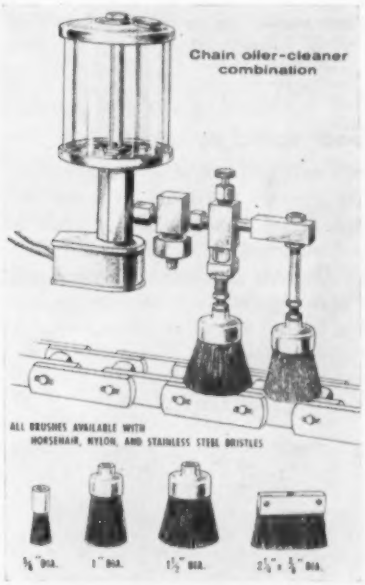
New line for heavy duty industrial applications has a movable contact assembly with two compressed coil springs to give quick make and break action. Leaf spring, carrying contacts, assures adequate contact pressure, eliminates points of zero pressure and provides non-teasing action even with very slow operating motion. Carrier spring gives enough contact wipe to assure good electrical contact on low voltage. Completely enclosed in molded phenolic case with high arc resistance, switches have electrical rating of 600v. Variety of operators for use in combination with basic switch give good versatility in use.

Cutler-Hammer, Inc., Milwaukee, Wisc.

Circle number 106 on reader service card

Oiler brushes

Choice of bristle material increases wearing qualities and variety of uses. Beside horsehair for normal lubricating, you may use nylon for high-speed chains where greater wear resistance is wanted, or stainless steel for high-temperature lubrication and chain cleaning. The last brush completely removes all foreign matter from chains operating in dirty sur-



roundings and gets rid of accumulated oil lubricant. Stainless steel shank brush precedes the lubricating brush so that protective film of oil goes on newly cleaned surface. Brush diameters of ⅝, 1, 1½ in.

Oil-Rite Corp., Manitowoc, Wisc.

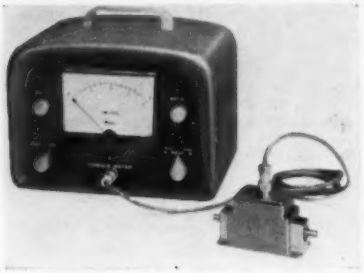
Circle number 107 on reader service card

Continued on next page

Continued from preceding page

Cargo torque meters

Torque ranges covered by new torquemeters are from 5 to 250 oz-in. full scale. Meters measure dynamic torques on shafts turning between 50 and 12,000 rpm with an accuracy within 2 percent full scale. Readings are independent of shaft speed and direction of rotation. For remote read-



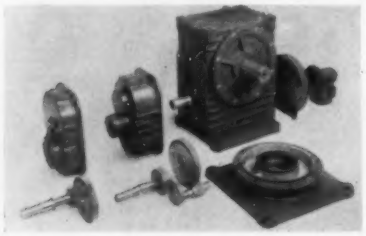
ings the indicator may be located where needed and connected electrically to the torque pickup. Housings for pickups are 3⅝ to 5 in. long, depending on range covered. Shafts are 1/4 in. dia and 7/16 in. long.

Metron Instrument Co., Denver, Colo.

Circle number 108 on reader service card

Gear speed reducers

New enlarged line of worm gear units has unusual flexibility of mounting and drive arrangements. Standardized mounting bases, single and double helical attachments, fans and torque control attachments permit top, bottom or side mounting with or without mounting base. Drive arrangements include horizontal, top or bottom, and vertical, shaft up or



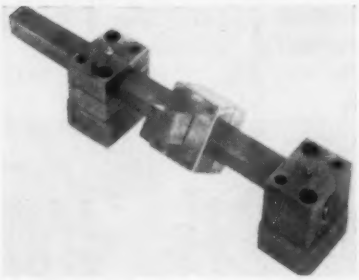
down. Available from stock, all ratios from 5-1/6 to 1 to 1212 to 1 with center distances from 3 to 21 in.

Philadelphia Gear Corp., Philadelphia, Pa.

Circle number 109 on reader service card

Pillow blocks

Solid and split styles for square shafts used in die automation. Blocks come



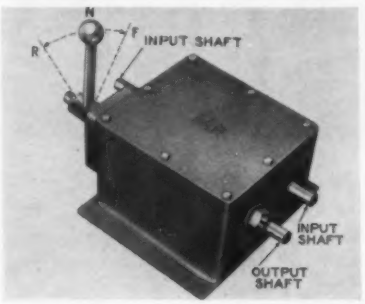
with replaceable bronze bushings which compensate for unusual wear due to rocking, rather than rotary motion, of the die automation shafts.

Jolico Industries, Allen Park, Mich.

Circle number 110 on reader service card

Reversing transmission

Designed for broad utility in light to medium power applications (up to 7½ hp) where instant, smooth reversing is desired. For "work horse" use in machine tools, small automotive units, farm and garden packages, material handling equipment, etc. Combines direct-gear and chain-drive principles with two opposing clutches with single-action lever engaging the clutches alternately for forward or



reverse drive. Both output and input shafts adapt to all types of power linkage.

Mentor Products, Inc., Transmission Div., Mentor, Ohio.

Circle number 111 on reader service card

Universal-mounting gear unit

Suitable for a wide variety of mounting positions, shaft dispositions and speed reduction ratios. In this unit, simplified design is common to worm gears of following types: standard (worm under wormwheel); inverted (wormwheel under worm); and vertical (wormshaft horizontal, wheelshaft vertical). Up to 50 mounting positions and different arrangements of input and output shafts. Unit can be supplied in motorized form. British line now available in 4, 6 and 8 in. centers for hp up to 50, stock ratios 5 to 1 and 7 to 1. Line will be enlarged shortly, according to manufacturer.

Crofts U. S. A., Inc., Chicago, Ill.

Circle number 112 on reader service card

Double shaft gearmotor

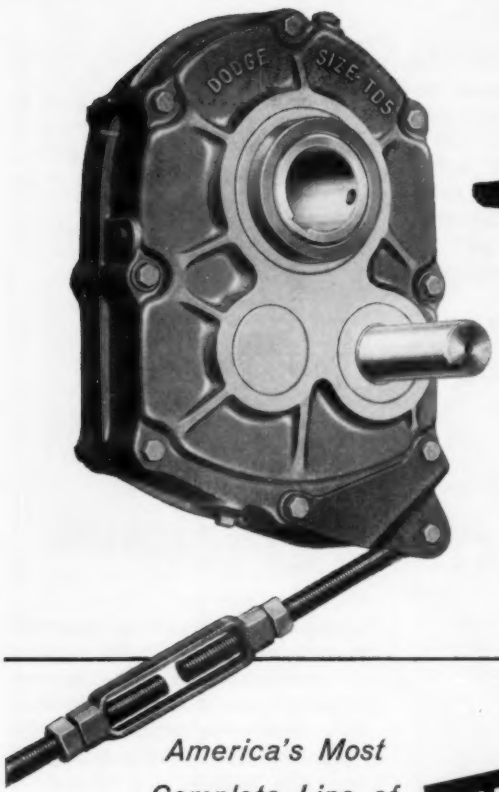
Driven by a 200 v a-c, 400 cycle, 3-phase motor. Typical of the speeds and torques which can be made available for custom requirements by various different types of gear sets is

1700 rpm at 96 oz-in. torque on one shaft, 4700 rpm at 650 oz-in. torque on opposite shaft.

Western Gear Corp., Electro Products Div., Pasadena, Calif.

Circle number 113 on reader service card

Continued on page 38



Torque-Arm

THE DODGE DEVELOPMENT THAT CHANGED THE NATION'S HABITS OF SPEED REDUCTION

America's Most Complete Line of Shaft Mounted Speed Reducers

55 MODELS

- Capacities up to 170 hp
- Output speeds from 10 to 378 rpm!
- Single Reduction
- Double Reduction
- 5 to 1 Ratio
- 15 to 1 Ratio
- 25 to 1 Ratio
- Any speed ratio up to 150 to 1 obtainable by selection of pre-determined combination of reducer and V-belt drive.

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

In fewer than ten years, the range of Torque-Arm Shaft Mounted Speed Reducers has increased from 6 to 55 models, to meet the ever increasing demand for this improved method of speed reduction.

By eliminating foundation, sliding base and flexible coupling this modern speed reducer has saved untold installation time and untold dollars of cost.

The rugged semisteel housing developed by Dodge has never been improved upon. It is corrosion resistant—and it has the strength to hold bearing seats in line for the life of the unit.

Dodge design provides wide spacing for the bearings. Loads are carried easily, contributing to Torque-Arm's long life and very high efficiency. The gears are finest quality—helical, heat treated steel.

Torque-Arm mounts vertically or horizontally in any position around the driven shaft. It locks to the shaft on *both* sides of the housing. The holes in the output hub provide simple removal with puller. Overload release and built-in backstop are optional.

Dodge Torque-Arm is America's most widely used shaft mounted speed reducer. It is stocked by your local Dodge Distributor. Ask him. Or write us for bulletin.

DODGE MANUFACTURING CORPORATION, 8200 Union, Mishawaka, Ind.

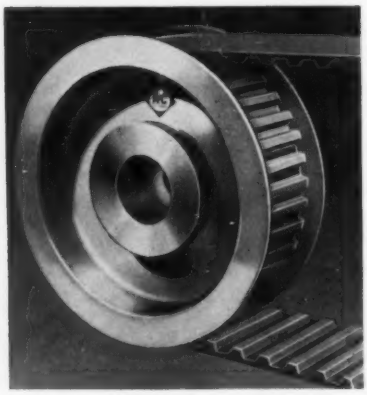
DODGE
of Mishawaka, Ind.

For more information circle No. 5 on the Reader Service Card

Continued from page 36

Timing belt drive

Time-Tex uses construction of steel cable cords imbedded in neoprene molded with nylon base fabric. Drives do not depend on friction, so there is no need for high initial tension. Small pulleys, short centers, narrow belts combine to reduce space needs while keeping high capacities. Heat



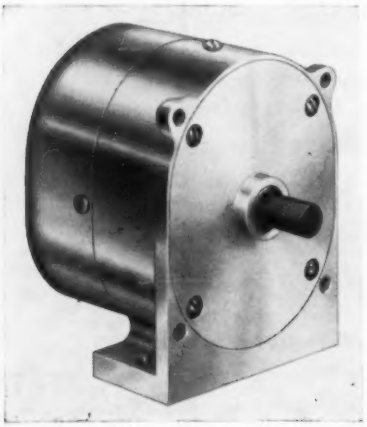
build-up is minimal. Sub-fractional to 600 hp, torque load ranges from in.-oz. to thousands of ft-lbs. Speeds to 16,000 fpm. 5 different pitches, various shaft diameters.

Allis-Chalmers Mfg. Co., Milwaukee, Wisc.

Circle number 114 on reader service card

Compact gearmotor

Expectional power in small space. Built for heavy, continuous duty, new gearmotor lends itself to use in vending machines, business machines, pumps, conveyors, machine tools, etc. For any single speed from ½ rpm to 1000 rpm, torques from 40 to 175



in.-lbs at 10 rpm, hp ratings from 1/65 to 1/20. Ball bearing motor, gears and pinions of hardened steel with large felt oil reservoirs touching every journal. All gear assemblies copper brazed. Base or panel mounted, totally enclosed with continual airflow over motor. 115v, 60 cycle a-c, special cycles and currents available.

New England Gear Works, Southington, Conn.

Circle number 115 on reader service card

Speed reducer line

Fin and fan cooled speed reducers, Hi-Line series, provide up to 80% greater capacity than other reducers of comparable size and weight. Space saving is achieved by heavier bearings and shorter center distance between worm and gear. External cooling fins plus integrally mounted air

circulating fan reduce heat rise, permitting speed reducer to handle greater capacity. Units come in six sizes, 1.33 to 5.25 in. center distance.

Ohio Gear Co., Cleveland, Ohio

Circle number 116 on reader service card

Key starter

New key-operated manual motor starter will fit any standard single-gang outlet box. Single-phase 115/230v starter is for direct operation of motors up to 1 hp. Open or NEMA type 1 surface-mounted enclosures, single- or double-pole design. Incorporates straight-through wiring and a plug-in heater.

General Electric Co., Schenectady, N. Y.

Circle number 117 on reader service card

Control units

Cyclematic controls are designed as electrical supply and control units for low-current (under ½ amp) electromagnetic clutch and/or brake units.

Required d-c voltage is converted from incoming 115, 230, 460 or 575 v a-c current. Controls incorporate potentiometer selection of acceleration and deceleration rates, as well as torque limitation protection. May be used with virtually any manual or automatic switching for start-stop cycles, positioning, jogging, etc.

Cycledynamics Inc., Detroit, Mich.

Circle number 118 on reader service card

Variable-speed pulley

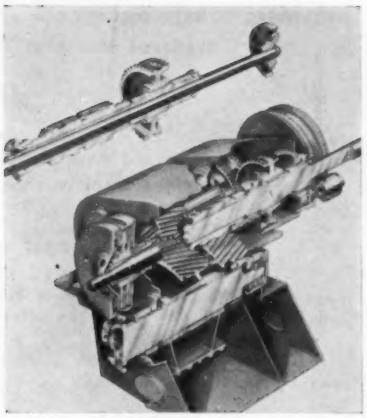
Provides ratios up to 3 to 1 at 3⅓ hp at 1150 rpm, or 5 hp at 1750 rpm. Pulley changes speed instantly with finger-tip pressure while machine is in motion. Both pulley faces move simultaneously for constant belt alignment, each side independently actuated by its own spring. Curved pulley faces keep full contact with belt sides for maximum efficiency. Four standard bores from 1 to 1⅜ in. Motor travel for full range is 4⅝ in. with 9.53 in. maximum and 3.17 in. minimum pitch diameters.

Lovejoy Flexible Coupling Co., Chicago, Ill.

Circle number 119 on reader service card

Marine gearing

New line of reverse and reduction gears utilizing pneumatic clutches for any diesel propulsion requirement from 800 to 20,000 hp. An unusual feature is location of clutches on the



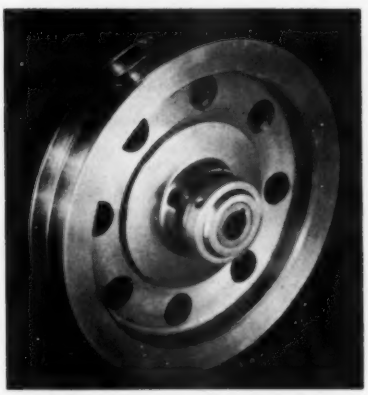
outside of the gear, independently supported by gear unit itself, and out of the way of the engine. This results in ease of inspection and replacement, superior air flow to clutches for good cooling, positive alignment between driven and driving elements, elimination of flexible coupling.

Western Gear Corp., Industrial Products Div., Belmont, Calif.

Circle number 120 on reader service card

Safety clutch line

Clutches give overload protection through slippage at any pre-set torque up to 300 in.-lb, with full drive reocurring automatically when torque



falls below pre-set value. Break-away settings are varied easily with threaded adjuster secured with recessed lock screw. Clutches are integral with single- or double-grooved sheaves. Five pitch diameters from 6.2 to 11 in. For shafts up to 1 in. dia.

Edgemont Machine Co., Dayton, Ohio.

Circle number 121 on reader service card

For more information on any components discussed in the feature or idea articles in this issue, fill out and mail blank below. This applies only to those articles referring to this page.

EDITOR, POWER TRANSMISSION DESIGN *AUGUST*, 1959
812 HURON ROAD, CLEVELAND 15, OHIO

Please send me more information on components discussed in articles below. I am listing only one component per line.

(1) ..... (Component Name) on page ..... in Article No. .....
(2) ..... (Component Name) on page ..... in Article No. .....
(3) ..... (Component Name) on page ..... in Article No. .....
(4) ..... (Component Name) on page ..... in Article No. .....

NAME .....POSITION .....
FIRM .....TYPE BUSINESS .....
ADDRESS ..... STATE.....

cut on dotted lines

EDITOR, POWER TRANSMISSION DESIGN *AUGUST*, 1959
812 HURON ROAD, CLEVELAND 15, OHIO

Please send me more information on components discussed in articles below. I am listing only one component per line.

(1) ..... (Component Name) on page ..... in Article No. .....
(2) ..... (Component Name) on page ..... in Article No. .....
(3) ..... (Component Name) on page ..... in Article No. .....
(4) ..... (Component Name) on page ..... in Article No. .....

NAME .....POSITION .....
FIRM .....TYPE BUSINESS .....
ADDRESS ..... STATE.....

cut on dotted lines

EDITOR, POWER TRANSMISSION DESIGN *AUGUST*, 1959
812 HURON ROAD, CLEVELAND 15, OHIO

Please send me more information on components discussed in articles below. I am listing only one component per line.

(1) ..... (Component Name) on page ..... in Article No. .....
(2) ..... (Component Name) on page ..... in Article No. .....
(3) ..... (Component Name) on page ..... in Article No. .....
(4) ..... (Component Name) on page ..... in Article No. .....

NAME .....POSITION .....
FIRM .....TYPE BUSINESS .....
ADDRESS ..... STATE.....

continued from page 20

Gear Losses

To figure increased torque and horsepower of a gear train resulting from increased center distance:

(1) Compute the mass moment of inertia of the new gear or increased mass moment of inertia, I, of the old one.

(2) Compute angular acceleration α required to obtain operating rpm of the gear.

The additional torque required will be

$$T_i = I \alpha r \quad \text{.....(6)}$$

Where

r = ratio of rpm of gear over rpm of driving pinion.

The additional horsepower required will then be

$$hp_i = \frac{T_i N}{63000} \quad \text{.....(7)}$$

where

T_i = torque in in-lbs
N = driving pinion rpm

Backlash Vs Center Distance

Adding more meshes to a gear train increases backlash and affects gear train accuracy. Even though the individual backlash of each mesh is small, the total backlash of the train becomes sizable. As shown in Fig. 2, the motor pinion could turn almost 1/32 inch on the pitch circle without the output shaft responding in the worst example. The table assumes equal velocity ratios for each mesh for class 4, commercial quality gears.

Drive shafts also introduce problems if too long. The curve in Fig. 1 shows angular torsional deflection of several shafts.

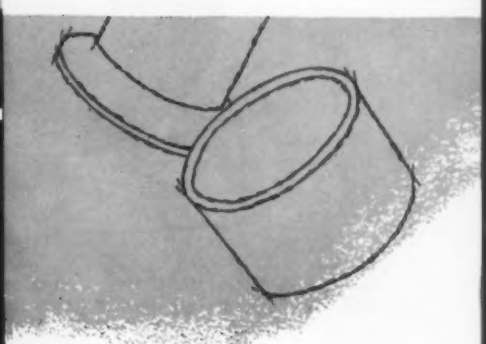
For example, a one inch diameter shaft (Shaft B) would twist more than 10 degrees if it had to deliver 25 horsepower over a length of 6 ft. These figures are based on steel for various angular velocities. As rpm changes, the values change.

Keeping power sources closer to work shafts also improves other factors. Floor space is decreased, maintenance is reduced and lubrication problems decrease. ▲▲▲

BEARINGS

DESIGN/APPLICATION

REGULAR MONTHLY SECTION OF IDEAS AND DEVELOPMENTS



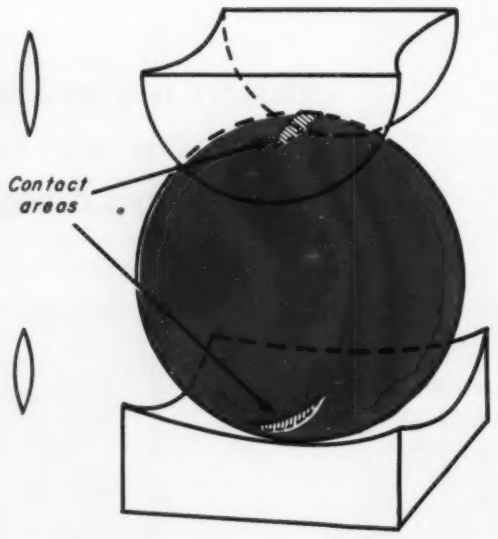
POWER TRANSMISSION DESIGN

August 1959

The ball in a bearing rolls . . . and rolls . . . and rolls

You can always depend

There's a ball bearing of every description



GROOVES WITH RADII of curvature equal to twice ball diameter increase load capacity 16 times.

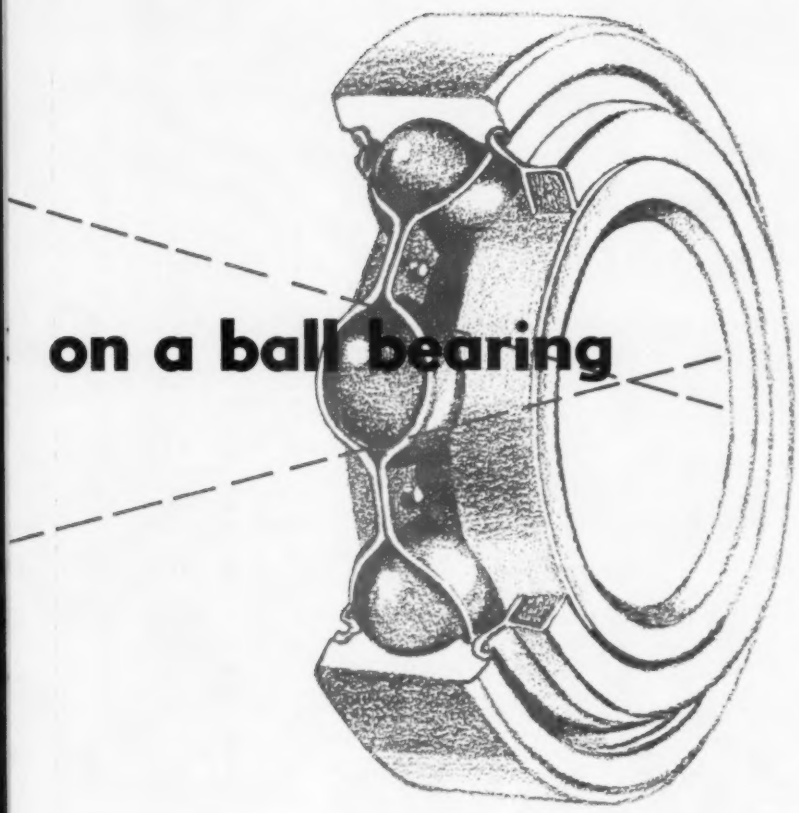
IF A ROUND BALL is pressed against a flat plate of the identical material, compression takes place. Flattening of the ball and indentation in the plate are of the same magnitude.

The resulting deformation is a mean dimension between that of the original surfaces. The material displaced on each surface increases the density of the mass behind which supports the area.

For the same average stress of all members in the contact area, a ball resting on a flat plate can support four times more load than when resting between two balls of the same diameter. If then, in place of the two balls there are substituted two members, shaped as shown in the drawing with grooves having radii of curvature equal to twice the ball diameter, the carrying capacity of the initial ball is increased 16 times.

To lessen stresses in the contact area, the curvatures must closely confine the ball and be accurately controlled in size. This is the thing that is done with extreme care by manufacturers.

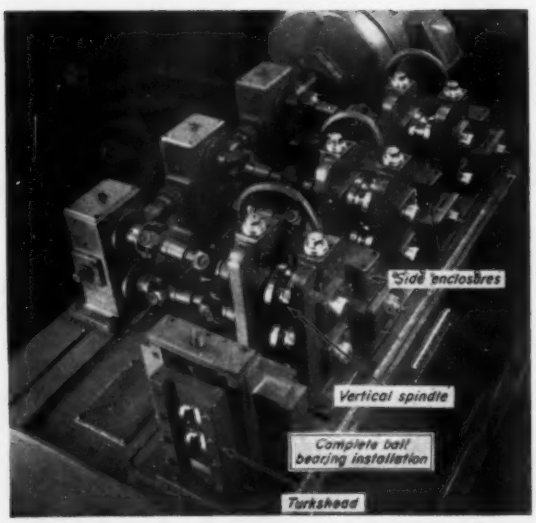
Stress in a bearing varies as the cube root of the load. For example, with a load increase of 100%, stress increases 26%.



on a ball bearing

For extra free reprints of this 12-page article, circle number 230 on Reader Service Card.

There's a ball bearing for every purpose



SIZING UNIT of tube mill has heavy duty ball bearings in vertical spindles, side enclosures and turksheads.

BALL BEARINGS are made in virtually every description and size for almost every kind of service. They come in a wide range of accuracies and in most cases, are tailored beforehand to the job you have in mind.

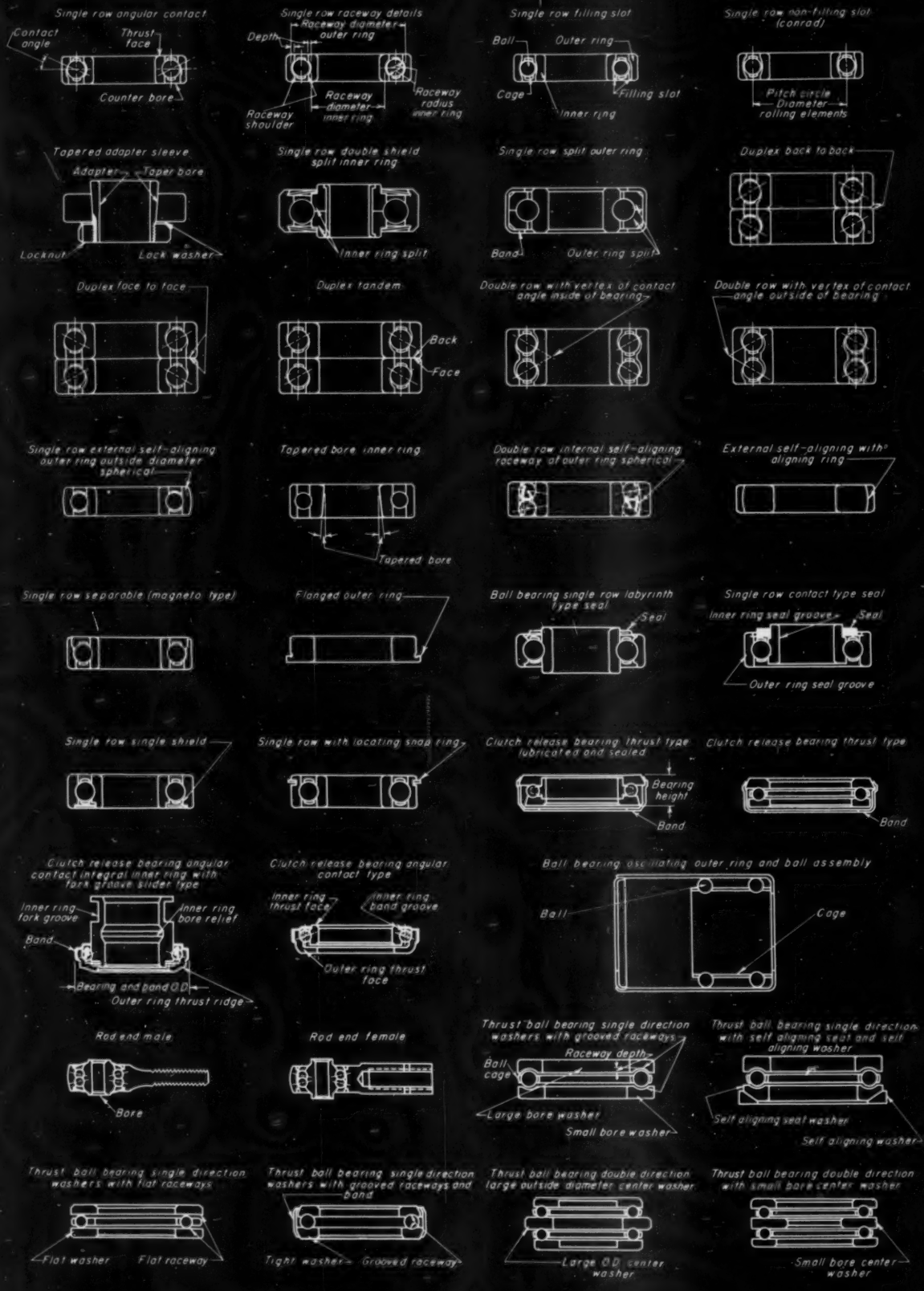
For general applications, bearings made to ABEC-1 (Annular Bearing Engineers' Committee) specification are very satisfactory.

For greater degree of accuracy, bearings to ABEC-3 tolerances are made with closer bore, OD and other size limitations.

For high speed shafts and applications that need extremely great rigidity and accuracy, ABEC-5 and ABEC-7 tolerance bearings are available. For ultra-precision work, bearings made to even closer tolerances can be purchased from many manufacturers.

In ABEC-5 specification and above, types are limited usually to single row radial, single row angular contact, duplex magneto and double row bearings. Some manufacturers, however, build all types of custom bearings and can supply you with 'anything' you want.

STANDARD AFBMA BALL BEARING TYPES



Load Problem

Find the basic load rating of a good quality double row bearing with six ¼ inch balls per race on a pitch diameter of .806 inch, and a contact angle of 0 degrees.

Solution

Here's the formula, but also refer to page 52.

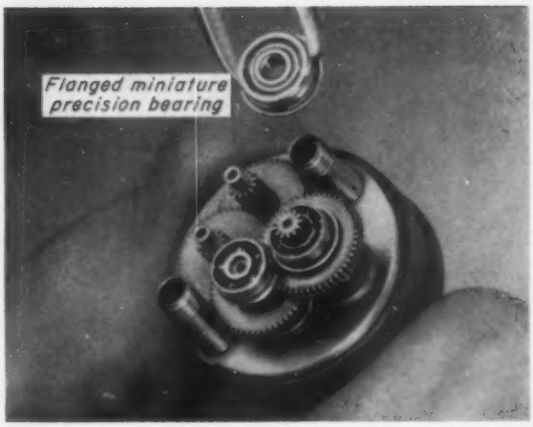
$C = f_c\ (i\ \cos\alpha)^{.7}\ Z^{.667}\ D^{1.8}$ .....(1)

$= 3980 \times 1.625 \times 3.30 \times .0825$

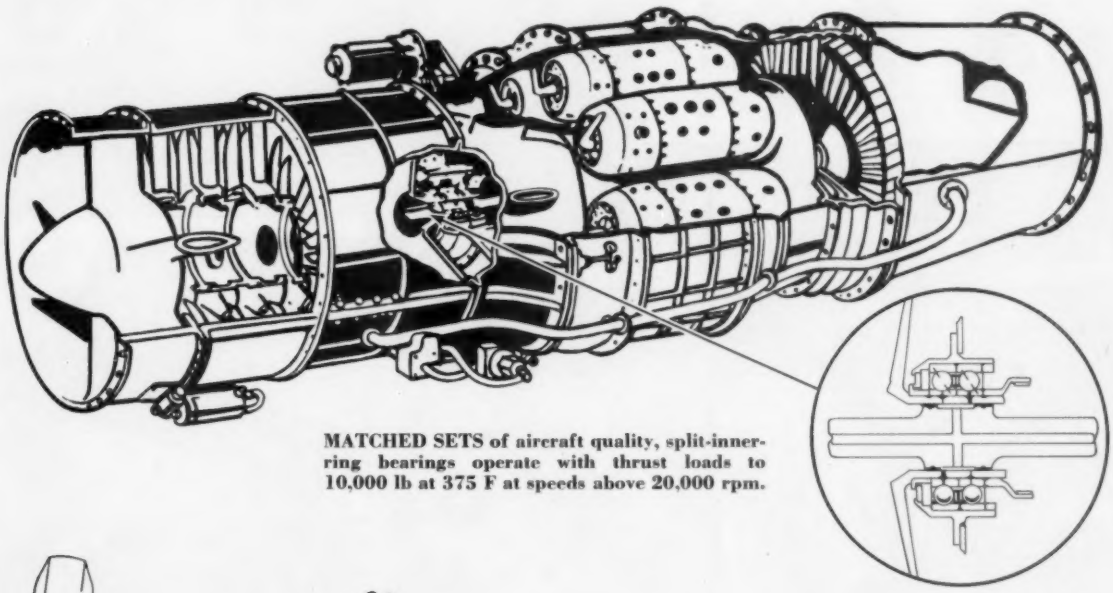
$= 1760$ lb.

Where

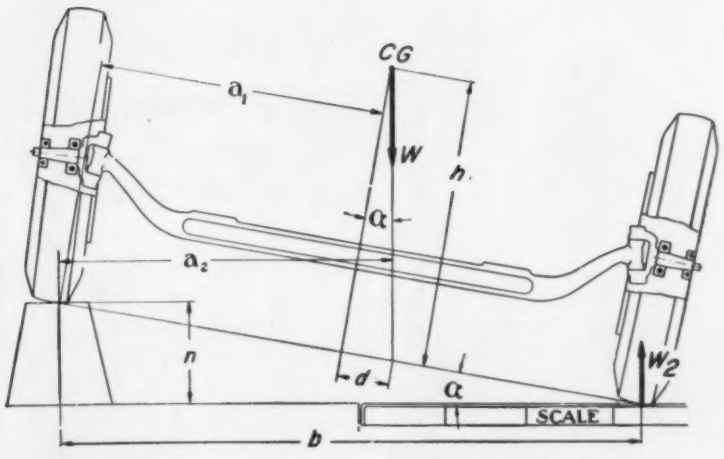
C = basic load rating, lb
D = ball diameter, inches
Z = number of balls per row
f_c = factor of bearing quality = 3980 in this instance
α = nominal angle of contact, degrees



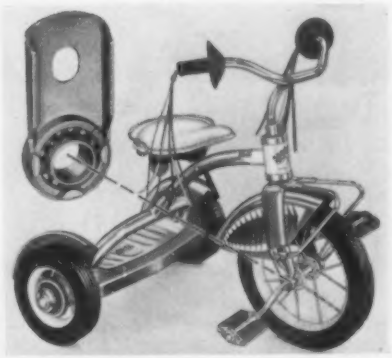
PRECISION MINIATURE BEARINGS are minutely accurate for computer gear train.



MATCHED SETS of aircraft quality, split-inner-ring bearings operate with thrust loads to 10,000 lb at 375 F at speeds above 20,000 rpm.



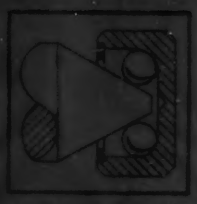
FRONT WHEEL, angular contact bearings carry both radial and axial wheel loads.



SEMI-PRECISION, split race bearings are low cost for wheel forks of tricycle.

TYPICAL SPECIAL BALL BEARINGS

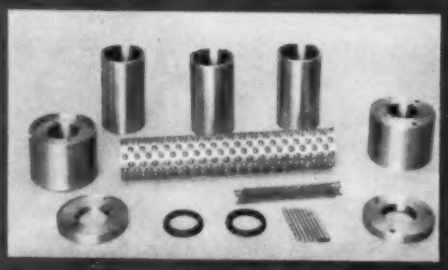
PRECISION MINIATURE



ANGULAR CONTACT, CLOSED END

SINGLE-FRACTURE SPLIT

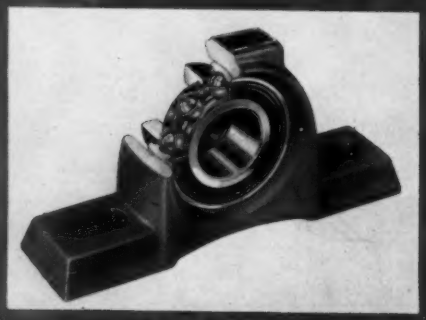
CONTOURED OUTER RACE



BEARING FOR THREADING MACHINE

V GROOVE OUTER RACE

LOW-COST PILLOW BLOCK



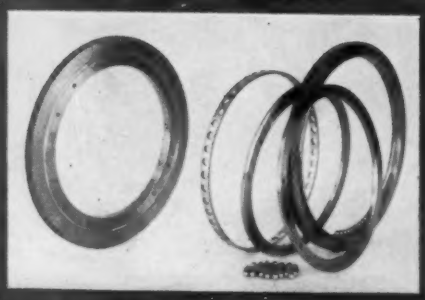
LUBRICATED-FOR-LIFE BEARING

LARGE CROSS-SECTION BEARING

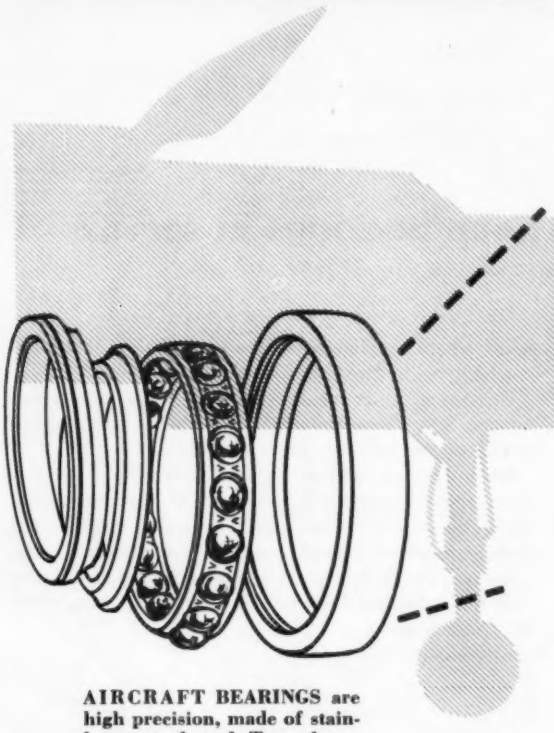
COMBINED

SPHERICAL

SEPARABLE INNER RING



OUTER CAGE HAS GEAR TEETH



AIRCRAFT BEARINGS are high precision, made of stainless or tool steel. Type shown is two piece inner ring, deep groove.

Shaft Fit

Excessive bearing looseness under load is objectionable. Creeping or slipping of the inner ring on the rotating shaft causes surface metal to wear off which further increases looseness.

Bearings should fit shafts tight enough to prevent this unless inner ring does not rotate.

If a minimum press fit of .0001 in. tight on the shaft is desired with a bore that has a total tolerance of .0005 in., and a total tolerance of .0005 in. for the shaft, maximum press fit will be

.0001 = minimum press fit
+.0005 = total shaft tolerance
+.0005 = total bore tolerance
.0011 = maximum tight fit in inches

When inner ring is pressed on shaft with .0011 in. press fit, ring expands approximately .0008 in. (about 80% to 90% of the press depending on how heavy the race is and how smooth the shaft surface).

The bearing should therefore have about .0008 in. initial internal radial looseness between the balls and the rings. If it does not, it becomes tight internally.

WIDE INNER RING, lubricated-for-life bearings provide maximum life in moist environment, have self-locking collar, fit easily on shaft.

Shields, seals and separators keep bearings in service

Shields help protect bearings from grit, metal chips and other foreign matter. They also help to retain a desirable amount of lubricant inside the bearing, but will not prevent lubricant from working into or out of the bearing. Shields are therefore closures having running clearances and yet are not seals. They do not make actual contact between stationary and rotating bearing parts.

Seals serve to exclude dirt and retain lubricant. Dirt is any foreign matter that negatively affects operation of the bearing.

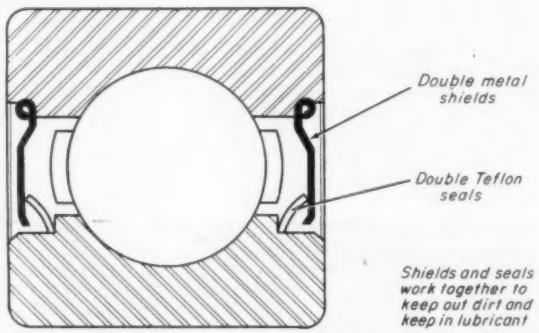
Ball bearing seals may be divided into two classes: contact type, those in which stationary and rotating parts are in actual rubbing contact under definite pressure; and clearance type, in which stationary and rotating parts are separated by a running clearance.

Contact seals are made from a considerable variety of materials such as felt, leather, flexible compositions, cork, plastics, metal fabric and many combinations of these.

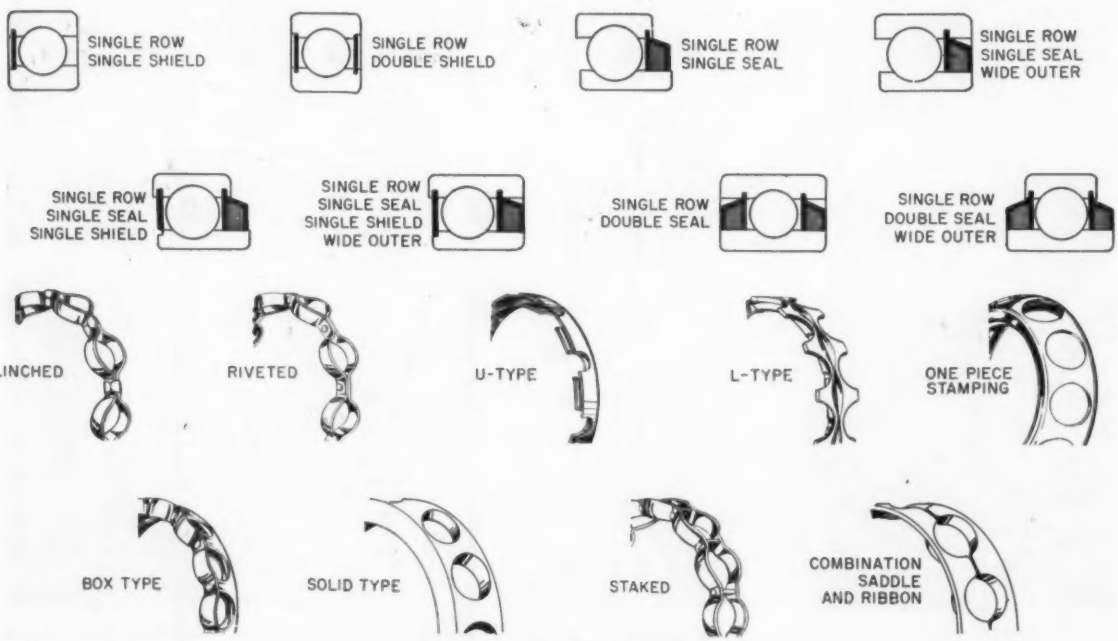
Clearance seals are also made of a wide variety of materials and are used with both oil and grease. They are frictionless and are not subject to wear. They are normally used at high speeds and at slower speed where maximum service is desired without adjustment or replacement of parts.

Separators (sometimes called cages or retainers) prevent balls from rubbing against each other which would cause friction, heat and wear.

In a bearing without a separator, the ball surfaces travel in opposite directions at the contact points. They rub together with a velocity equal to twice the surface speed of a single ball. With a separator, rubbing velocity is halved. Separators minimize contact with the balls and help keep a lubricating film along the contact areas.



Shields and seals work together to keep out dirt and keep in lubricant



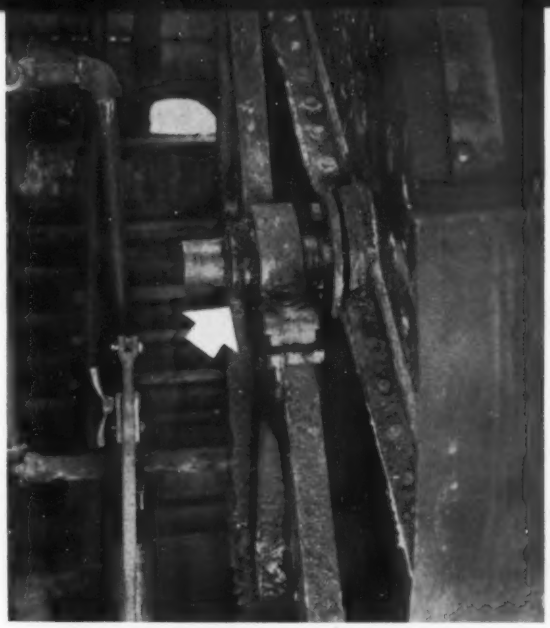
STANDARD SHIELDS, seals and separators. There are many other special types.

Why Pre-Load?

In a radial ball bearing, increasing the load does not increase the accuracy of centering the supported shaft. In an angular contact bearing, however, increase of load does increase firmness of centering.

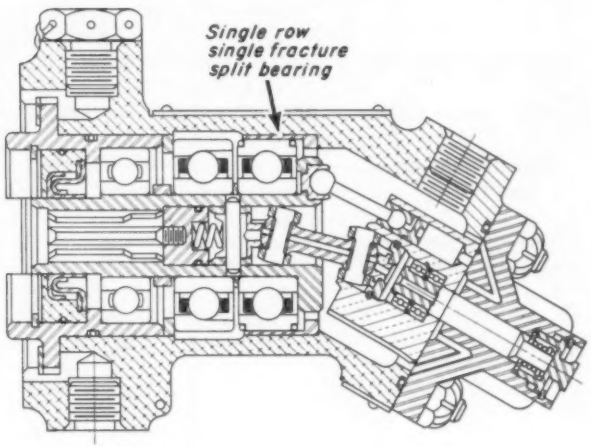
Pre-loading is a means of eliminating initial shaft deflection such that further loading causes only negligible additional deflection.

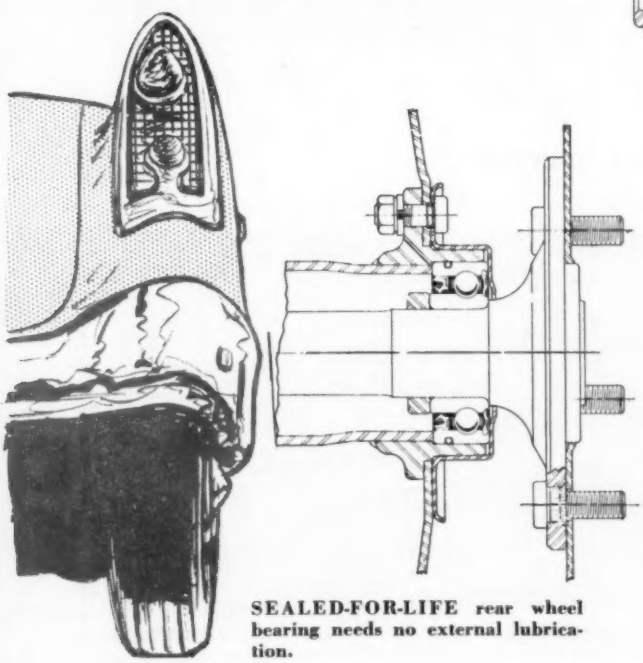
If a sleeve between two bearings is moved toward the one by a preloading nut to such an extent that an internal load is imposed between the bearings, the shaft between the bearings is placed in tension and the bearings have each been deflected a fixed distance.



LUBRICATED-FOR-LIFE pillow block contains permanently-sealed bearing. Abrasive material is sealed out, lubricant sealed in.

DEEP-GROOVE SPLIT bearing has more balls and high tolerance to momentary thrust loads.





SEALED-FOR-LIFE rear wheel bearing needs no external lubrication.

If an external thrust load is applied, it causes only slight increase in deflection of the front bearing, decreases shaft tension, and partially relieves the preload on both bearings.

Therefore, the front bearing is carrying less than the sum of external and internal loads and the rear bearing is carrying less than the original preload.

Since the rear bearing has been relieved of some preload by deflection of the front bearing due to the external load, the rear bearing partially resumes its original shape at the same rate at which it was deflected.

Preload relief, however, is the same for both bearings. The relief amount must be subtracted from the original load on the rear bearing. The difference between the loads on the front and rear bearings will equal the external load. When the preload was imposed, both bearings were equally loaded and were, therefore, deflected an equal amount.

Glossary of descriptive terms

ABEC 1, 3, 5, 7 — *Annular Bearing Engineers' Committee of Anti-Friction Bearing Manufacturers Association (AFBMA) tolerance standards*

Angle of contact — *Angle between plane perpendicular to bearing axis and line drawn between points of tangency of balls to inner and outer rings*

Contact seal — *Closure that connects inner and outer rings with rubbing contact*

Duplex bearings — *Matched set, usually preloaded*

End play — *Total movement parallel to bearing axis when specified load is applied in one direction, then in other*

Extra small bearing — *Bearing with metric bore under 10 mm*

Filling slot assembly — *Bearings with side-notched raceways to permit ball assembly*

Floating bearing — *Bearing mounted freely to move axially*

Full type bearing — *Has no separator; has maximum number of balls*

Inch dimension bearing — *Has boundary dimensions of integral or fractional inch figures, not metric*

Self-aligning — *One raceway spherical*

Clearance seal — *Closure between inner and outer ring spaced in close proximity to, but does not rub, rotating member*

Lubricating groove — *Continuous recess in either ring for conveying lubricant*

Metric bearing — *Bore, OD and others dimensions expressed in integral millimeters*

Miniature bearing — *Outside diameter below and not including 3/8 in. or 9 mm*

Raceway — *Track in either ring in which balls travel*

Radial clearance — *Total diametral movement of unclamped ring when specified load is reversed*

Radial runout — *Difference between minimum and maximum readings on center of outer ring with inner ring mounted on tapered arbor and rotated one revolution, outer ring stationary*

Separable — *A bearing that may be disassembled into component parts; either or both rings may be broken along groove axis or have loading slot*

Separator (cage, retainer) — *Device that surrounds balls and rotates with them. Keeps balls spaced and prevents ball rubbing*

Split — *Single or complete fracture of either ring across raceway faces; may be assembled around shaft rather than slid onto it*

Unground — *Bearing with unground raceways*

Ball bearing sources

Acme Ball Bearing Company
Aetna Ball & Roller Bearing Co.
Airtex Products, Inc.
American Ball Bearing Company
Andrews Bearing Company
Ann Arbor Bearing & Manufacturing Company
Ball & Roller Bearing Company
Bantam Bearings Div., The Torrington Company
The Barden Corporation
Bearings Co. of American, Div. of Federal-Mogul-Bower Bearings
Bearing Service Company
Bearings Manufacturing Company
Bilodeau Ball Bearing Works, Inc.
Burgess-Norton Manufacturing Co.
Chapman Transmission Corporation
Consolidated Bearings Co., Inc.
deGroh Bearing Company
Ex-Cell-O Corporation
The Fafnir Bearing Company
The Federal Bearings Co., Inc.
Freeway Washer & Stamping Co., Bearing Division
General Bearing Company
The Green Ball Bearing Company
Halax Corporation
Harris & Reed Manufacturing Co.
Hartford Steel Ball Company, Inc.
Hoover Ball & Bearing Co.
Industrial Tectonics, Inc.
Joy Ball Bearing Corporation
Kaydon Engineering Corporation
Kilian Manufacturing Corporation
L & S Bearing Company
Landis & Gyr, Inc.
Link-Belt Company
Marlin-Rockwell Corporation
McCauley Industrial Corporation
McGill Manufacturing Company
Messinger Bearings, Inc.
Microtech Corporation
Miniature Precision Bearings, Inc.
New Departure, Division of General Motors Corporation
New Hampshire Ball Bearings, Inc.
Nice Ball Bearing Company
Norma-Hoffman Bearings Corp.
Orange Roller Bearing Company, Inc.
Reed Instrument Bearing Company
Saginaw Product Corporation
Schatz Manufacturing Company
SKF Industries, Incorporated
Split Ballbearings
Stephens-Adamson Manufacturing Company
William H. Stevenson Company
Trumbull Bearing & Engineering Co.
Zubler Bearing Corporation

Load Distribution Equation

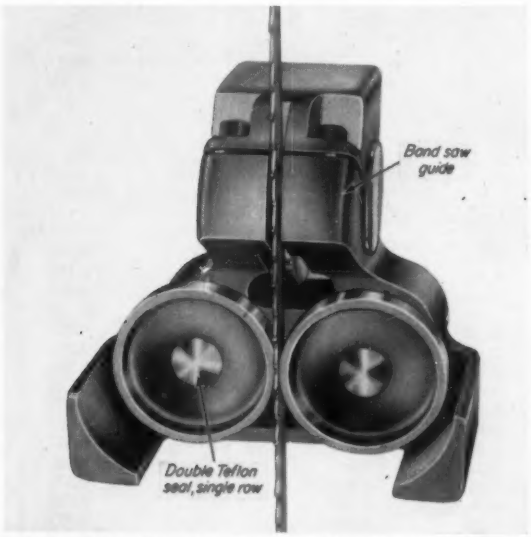
Pure radial loads applied to ball bearings are not evenly distributed through all the balls.

To illustrate, consider the five top balls in a bearing with one of the balls at top center. When load is applied vertically to the outer ring, the top ball receives the heaviest load. The two adjoining balls, one on each side, receive somewhat less but equal amounts. The next pair are equally loaded but to a still lesser extent.

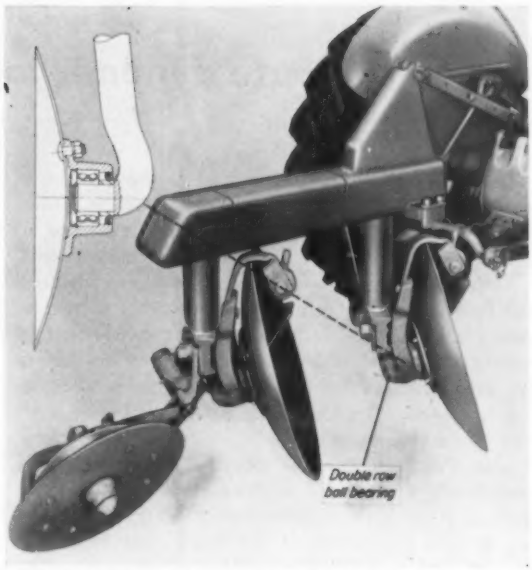
Therefore, because of the deformation in the balls and rings in the contact areas, the outer ring will move slightly downward so that all the balls in the lower half are relieved of load.

Designating the total load P and the vertical approach between inner and outer races δ, then

$$P=P_0+2P_1\cos\alpha+2P_2\cos 2\alpha+2PN\cos N\alpha \quad \text{.....(1)}$$



DOUBLE-CONTACT, Teflon-sealed bearings have shields on both sides.



PRE-LOADED angular contact bearings are small and support heavy combined radial and thrust loads.

where N is less than one-fourth the total number of balls, and α is the angle between the balls.

Therefore $N\alpha < 90$ deg. The approach, δ_0 corresponds to the ball load P_0 δ_1 to load P_1, etc. Then $\delta_1 = \delta_0 \cos\alpha$, $\delta_2 = \delta_0 \cos 2\alpha$, etc.

Total compression, δ_0, varies as $P_0^{2/3}$. Conversely, P_0 varies as $\delta_0^{2/3}$.

Thus

$$\frac{P_1}{P_0} = \frac{\delta_1^{3/2}}{\delta_0^{3/2}} \text{ and } \frac{P_2}{P_0} = \frac{\delta_2^{3/2}}{\delta_0^{3/2}}, \text{ etc.}$$

But $\delta_1 = \delta_0 \cos\alpha$ and $\delta_2 = \delta_0 \cos 2\alpha$, etc. .....(2)

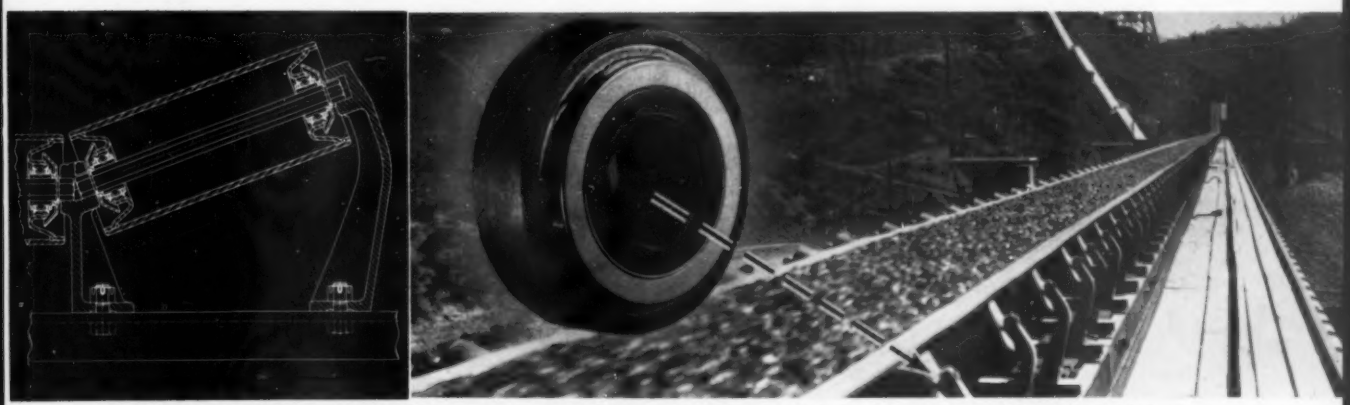
Therefore

$$P_1 = P_0 \cos^{3/2}\alpha \text{ and } P_2 = P_0 \cos^{3/2} 2\alpha, \text{ etc.} \quad \text{.....(3)}$$

And

$$P = P_0 (1 + 2\cos^{5/2}\alpha + 2\cos^{5/2} 2\alpha + 2\cos^{5/2} N\alpha \quad \text{..(4)}$$

which is the load distribution equation.



HEXAGONAL BORE BEARING mounts easily on hexagonal conveyor shaft, has seals on both sides and is protected from water and dirt by flanged guard.

How to compute dynamic load ratings for radial bearings

Life of a ball bearing is defined as the number of revolutions (or hours at some given constant speed) which a bearing will run before first evidence of fatigue in either ring or of any of the rolling elements.

Rating life is a figure based on a group of identical ball bearings and is defined as the number of revolutions (or hours at some given constant speed) that 90 percent of the group will complete or exceed before the first evidence of fatigue. This life is approximately one-fifth the life which 50 percent of the bearings will complete or exceed.

Basic load rating is that constant stationary radial load which a group of identical ball bearings with stationary outer ring can endure for a rating life of one million revolutions of the inner ring. In single-row angular-contact ball bearings, the basic load rating relates to the radial component of the load, which results in a purely radial displacement of the rings in relation to each other.

Load ratings, when given for specific speeds, are based on a rating life of 500 hours.

Equivalent load is defined as that constant stationary radial load, which, if applied to a bearing with rotating inner ring and stationary outer ring, would give the same life as that which the bearing will attain under the actual conditions of load and rotation.

Basic Load Rating Formula

Magnitude of basic load rating C for radial and angular-contact bearings, except filling slot, with balls not larger than 25.4 millimeters or 1 inch in diameter is

$$C = f_c\ (i \cos\alpha)^{0.7} Z^{2/3} D^{1.8} \quad \text{.....(1)}$$

With balls larger than 25.4 mm in diameter, when kilogram and millimeter units are used

$$C = f_c\ (i \cos\alpha)^{0.7} Z^{2/3}\ 3.647 D^{1.4} \quad \text{.....(2)}$$

With balls larger than 1 inch in diameter when pound and inch units are used

$$C = f_c\ (i \cos\alpha)^{0.7} Z^{2/3} D^{1.4} \quad \text{.....(3)}$$

Where

i = number of rows of balls
α = nominal angle of contact
Z = number of balls per row
D = ball diameter
f_c = factor which depends on the units used, geometry of bearing components, accuracy to which parts are made, and material

Values of f_c are obtained by multiplying the value of $\frac{f_c}{f}$ from the appropriate column of Fig. 1 by a factor f. For kg and mm units, f = 10; for lb and in. units, f = 7450.

Approximate rating life L for ball bearings, except filling slot, is

$$L = \left(\frac{C}{P}\right)^3 \text{million revolutions} \quad \text{.....(4)}$$

Where

P = equivalent load

Magnitude of equivalent load P for radial and angular-contact ball bearings of conventional types, except filling slot, under combined constant radial and constant thrust loads is:

$$P = XVF_r + YF_a \quad \text{.....(5)}$$

Where

X = radial factor
V = rotation factor
Y = thrust factor
F_r = radial load
F_a = thrust load

Continued on page 63

Figure 1
Factor f_c/f

$\frac{D \cos \alpha^*}{d_m}$	Single-Row Radial-Contact, Single- and Double-Row Angular Contact Groove †	Double-Row Radial Contact Groove	Self-Aligning
0.05	0.476	0.451	0.176
0.06	0.500	0.474	0.190
0.07	0.521	0.494	0.203
0.08	0.539	0.511	0.215
0.09	0.554	0.524	0.227
0.10	0.566	0.537	0.238
0.12	0.586	0.555	0.261
0.14	0.600	0.568	0.282
0.16	0.608	0.576	0.303
0.18	0.611	0.579	0.323
0.20	0.611	0.579	0.342
0.22	0.608	0.576	0.359
0.24	0.601	0.570	0.375
0.26	0.593	0.562	0.390
0.28	0.583	0.552	0.402
0.30	0.571	0.541	0.411
0.32	0.558	0.530	0.418
0.34	0.543	0.515	0.420
0.36	0.527	0.500	0.421
0.38	0.510	0.484	0.418
0.40	0.492	0.467	0.412

*d_m denotes pitch diameter of ball set. For values of $\frac{D \cos \alpha}{d_m}$ other than given f_c/f is obtained by linear interpolation.

† (1) When calculating basic load rating for unit consisting of two similar single-row radial-contact bearings in duplex mounting pair is considered as one double-row radial-contact ball bearing.

(2) When calculating basic load rating for unit consisting of two similar single-row angular-contact ball bearings in duplex mounting, face-to-face or back-to-back, pair is considered as one double-row angular-contact bearing.

(3) When calculating basic load rating for unit consisting of two or more similar single-row angular-contact ball bearings mounted in tandem, and mounted for equal load distribution, rating of combination is number of bearings to the 0.7 power times rating of single-row ball bearing. This is based on assumption that the several bearings are considered as one unit. If, for some technical reason, unit may be treated as number of individually interchangeable single-row bearings, this footnote (3) does not apply.

Figure 2
Factors X V, and Y

Bearing Type			In Relation to the Load the Inner Ring Is		Single-Row Bearings*		Double-Row Bearings†				e
			Rotating	Stationary	$\frac{F_a}{VF_r} > e$		$\frac{F_a}{VF_r} \leq e$		$\frac{F_a}{VF_r} > e$		
			V	V	X	Y	X	Y	X	Y	
Radial-Contact Groove Ball Bearings‡	$\frac{F_a}{C_o}$§	$\frac{F_a}{iZD^2}$ Units lb in.									
	0.014	25				2.30				2.30	0.19
	0.028	50				1.99				1.99	0.22
	0.056	100				1.71				1.71	0.26
	0.084	150	1	1.2	0.56	1.55	1	0	0.56	1.55	0.28
	0.11	200				1.45				1.45	0.30
	0.17	300				1.31				1.31	0.34
	0.28	500				1.15				1.15	0.38
	0.42	750				1.04				1.04	0.42
	0.56	1000				1.00				1.00	0.44
Angular-Contact Groove Ball Bearings with Contact Angle‡ 5 Degrees	$\frac{iF_a}{C_o}$§	$\frac{F_a}{ZD^2}$ Units lb. in.			For this type use the X, Y, and e values applicable to single-row radial contact bearings						
	0.014	25						2.78		3.74	0.23
	0.028	50						2.40		3.23	0.26
	0.056	100						2.07		2.78	0.30
	0.085	150	1	1.2			1	1.87	0.78	2.52	0.34
	0.11	200						1.75		2.36	0.36
	0.17	300						1.58		2.13	0.40
	0.28	500						1.39		1.87	0.45
	0.42	750						1.26		1.69	0.50
	0.56	1000						1.21		1.63	0.52
10 Degrees	0.014	25				1.88		2.18		3.06	0.29
	0.029	50				1.71		1.98		2.78	0.32
	0.057	100				1.52		1.76		2.47	0.36
	0.086	150				1.41		1.63		2.29	0.38
	0.11	200	1	1.2	0.46	1.34	1	1.55	0.75	2.18	0.40
	0.17	300				1.23		1.42		2.00	0.44
	0.29	500				1.10		1.27		1.79	0.49
	0.43	750				1.01		1.17		1.64	0.54
	0.57	1000				1.00		1.16		1.63	0.54
15 Degrees	0.015	25				1.47		1.65		2.39	0.38
	0.029	50				1.40		1.57		2.28	0.40
	0.058	100				1.30		1.46		2.11	0.43
	0.087	150				1.23		1.38		2.00	0.46
	0.12	200	1	1.2	0.44	1.19	1	1.34	0.72	1.93	0.47
	0.17	300				1.12		1.26		1.82	0.50
	0.29	500				1.02		1.14		1.66	0.55
	0.44	750				1.00		1.12		1.63	0.56
	0.58	1000				1.00		1.12		1.63	0.56
20 Degrees			1	1.2	0.43	1.00	1	1.09	0.70	1.63	0.57
25 Degrees			1	1.2	0.41	0.87	1	0.92	0.67	1.41	0.68
30 Degrees			1	1.2	0.39	0.76	1	0.78	0.63	1.24	0.80
35 Degrees			1	1.2	0.37	0.66	1	0.66	0.60	1.07	0.95
40 Degrees			1	1.2	0.35	0.57	1	0.55	0.57	0.93	1.14
Self-Aligning Ball Bearings			1	1	0.40	0.4 cot α	1	0.42 cot α	0.65	0.65 cot α	1.5 tan α

* For single-row bearings, when $F_a/VF_r \leq e$, use $X = 1$ and $Y = 0$. Two similar single-row angular-contact ball bearings mounted face-to-face or back-to-back are considered as one double-row angular-contact bearing.

For two or more similar single-row ball bearings mounted in tandem, use values of X, Y, and e which apply to one single-row ball bearing. When α is smaller than 20 degrees, F_r and F_a are not total loads but loads per single-row bearing. C_o and i also refer to one single-row bearing.

† Double-row bearings are presumed to be symmetrical.

‡ Permissible maximum value of F_a/C_o depends on the bearing design.

§ C_o is the basic static load rating.

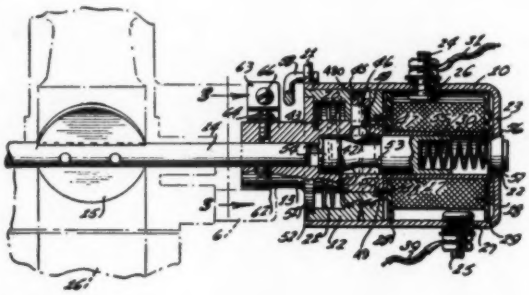
Values of X, Y and e for a load or contact angle other than shown are obtained by linear interpolation.

PATENTS

Speed Governor

U. S. Patent 2,870,892; *Henry E. Hiner, Petersburg, W. Va.*

Speed control element for use on motor vehicles. It comprises a cup-shaped housing; a bushing having an annular recess positioned in the housing; a hub having an annular flange that fits in the bushing's recess; a shaft extending into and connected with the hub; a sleeve extended from the hub into the housing



and positioned in the bushing; a reciprocating latching pin mounted in the bushing, which engages the sleeve and prevents its relative rotation with respect to the bushing (the hub has a single bore for engagement so latching can occur in only one relative position of the hub); a tapered plunger slidably mounted in the housing; a ball mounted in the housing for engagement with the latching pin and the tapered plunger; a spring in the housing, connected to the sleeve and bushing, for rotating the sleeve and hub with respect to the bushing; a solenoid in the housing; and a core slidably mounted in the solenoid for moving the plunger, thereby causing the ball to move the latching pin out of engagement with the sleeve and permitting the sleeve and hub to be rotated.

Change-Speed Device

U. S. Patent 2,867,127; *Henri Fehr, Montmorency, France, assignor to Societe Anonyme dite: Compagnie de Construction Mechanique, Procedes Sulzer, Paris, France.*

An engine shaft drives first and second adjacent, coaxial, rotary field magnets carried on nonmagnetic plates. Contained in a fixed tubular member coaxial with the engine shaft are a shaft and an armature fixed to the shaft. Outside the fixed member and coaxial with it is another hollow shaft to which an armature is fixed. There are also two fixed field members. This makes up a pair of synchronous, homopolar clutches. Each clutch connects to a separate gear train so that energizing one stationary field selects one train of gears and energizing the other field member selects the other train.

LITERATURE on drives and components

Bearing line

Pitchlign roller bearings and followers with and without inner races in a wide range of dimensions and capacities are listed with complete specifications in 32-page catalog SF-88. Useful interchangeability lists and maintenance information are included.

Roller Bearing Co. of America, West Trenton, N. J.

Circle number 25 on reader service card

Universal joint

Special brake mounting attaches brake disc or drum to the transmission flange, independent of the bolts that attach the joints to the flange. Entire unit may thus be perfectly balanced.

Mechanics Universal Joint Div., Borg-Warner Corp., Rockford, Ill.

Circle number 13 on reader service card

New a-c contactor

Type 426 medium-voltage, oil-immersed contactor design is well shown in illustrated bulletin 14B8752. Rated at 400 amp, 5 kv, 50 mva in a small tank mounted in small-size front-access starter, the oil-immersed unit has important advantages for safe operation in hazardous, corrosive or dusty situations. Oscillograph reproductions of actual tests are included.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Circle number 26 on reader service card

V-belt catalog

Mor-Grip line is effectively presented in illustrated catalog v-55, 22 pages in color. Included are standard full horsepower V-belts in choice of three cross-section constructions; also multiple belts, super belts, steel cable high-tensile belts, open-end and hexagon double belts for wide variety of application needs. Full specifications and ordering information are given.

Maurey Mfg. Corp., Chicago, Ill.

Circle number 12 on reader service card

Universal motors

Bulletin 444, six illustrated pages, shows series motors for ac or dc operation with high starting torque, high operating speeds and adaptability to speed control. Specially good for intermittent fixed rotation operation, though adaptable to continuous duty and reversible uses. Pad, end or foot mountings are shown. Motors are available in standard ratings from 1/50 to ½ hp.

Robbins & Myers, Inc., Motor Div., Springfield, Ohio.

Circle number 27 on reader service card

Clutch-brake control

Electric clutch-brake unit gives direct operation with full pushbutton control of motor drives, no solenoids or high-pressure piping required. Split-second engagement and release increase productivity and permit highly accurate positioning. Unit can often replace 1000 lb of hardware.

Warner Electric Brake & Clutch Co., Beloit, Wis.

Circle number 20 on reader service card

Coupling line

Illustrated catalog C-210-B shows specifications, uses and benefits of steel and zinc alloy couplings. Included are fixed-bore and bushed-type flexible couplings, jaw-type, chain, sleeve and rigid couplings. Engineering data on load classifications and service factors is given.

Browning Mfg. Co., Maysville, Ky.

Circle number 28 on reader service card

Speed reducers

Fractional to 3 hp, wide range of ratios. Removable base plate lets worm shaft be above or below worm wheel. Oversize shafts, lightweight housings are also featured. Catalog P-8 gives full information.

Euclid Universal Machine, Inc., Wickcliffe, Ohio.

Circle number 8 on reader service card

Bearing lubrication

Lubrication of miniature instrument bearings is the subject covered in a new, unusual manual, claimed by sponsoring manufacturer to be the first of its kind in the miniature bearing field. It supplies information on the various types and brands of oils and greases available to designers and users, with full data on properties, applications, standards and military specifications. Blending charts, nomographs and other graphic aids are included.

Miniature Precision Bearings, Inc., Keene, N. H.

Circle number 29 on reader service card

Torque motors

New torque bulletin gives basic facts about torque motors and shows applications. Company's line is designed to deliver maximum rated torque without damage to windings when stalled across the line at full voltage for predetermined periods.

Peerless Electric Co., Warren, Ohio.

Circle number 14 on reader service card

Long-lived parts

"Armored" process involves metallurgical combination formulae and special heat-treating finishing methods resulting in longer wear life for parts, with hardened wearing surfaces and tough, shock-resistant cores. Some products benefitting from this process are gears of all sizes and kinds, pinions and shafts, drums, racks, wheels, etc. Handsome, 34-page profusely illustrated booklet gives detailed information.

Pittsburgh Gear Co., Pittsburgh, Pa.

Circle number 30 on reader service card

Improved V-belts

DA 358 belts have increased sidewall area which, together with domed top, frees entire sidewall for transmission purposes. New strength member used gives 40 percent reduction in number of cross-sections needed for multiple drives.

Durkee-Atwood Co., Minneapolis, Minn.

Circle number 6 on reader service card

Continued on page 58

Nomograms for complete multiple

V-BELT DRIVE 1

EXAMPLE

A V-belt drive is to transmit 85 hp from a motor operating at 1200 rpm to a shaft which is to run at 400 rpm. The center distance between pulleys is approximately 42 inches.

Determine size of belts, diameters of pulleys and number of belts required.

SOLUTION

Assume belt speed of 4000 fpm

Then

$$d = \frac{12\,V}{\pi\,n} \quad \ldots\ldots (4)$$

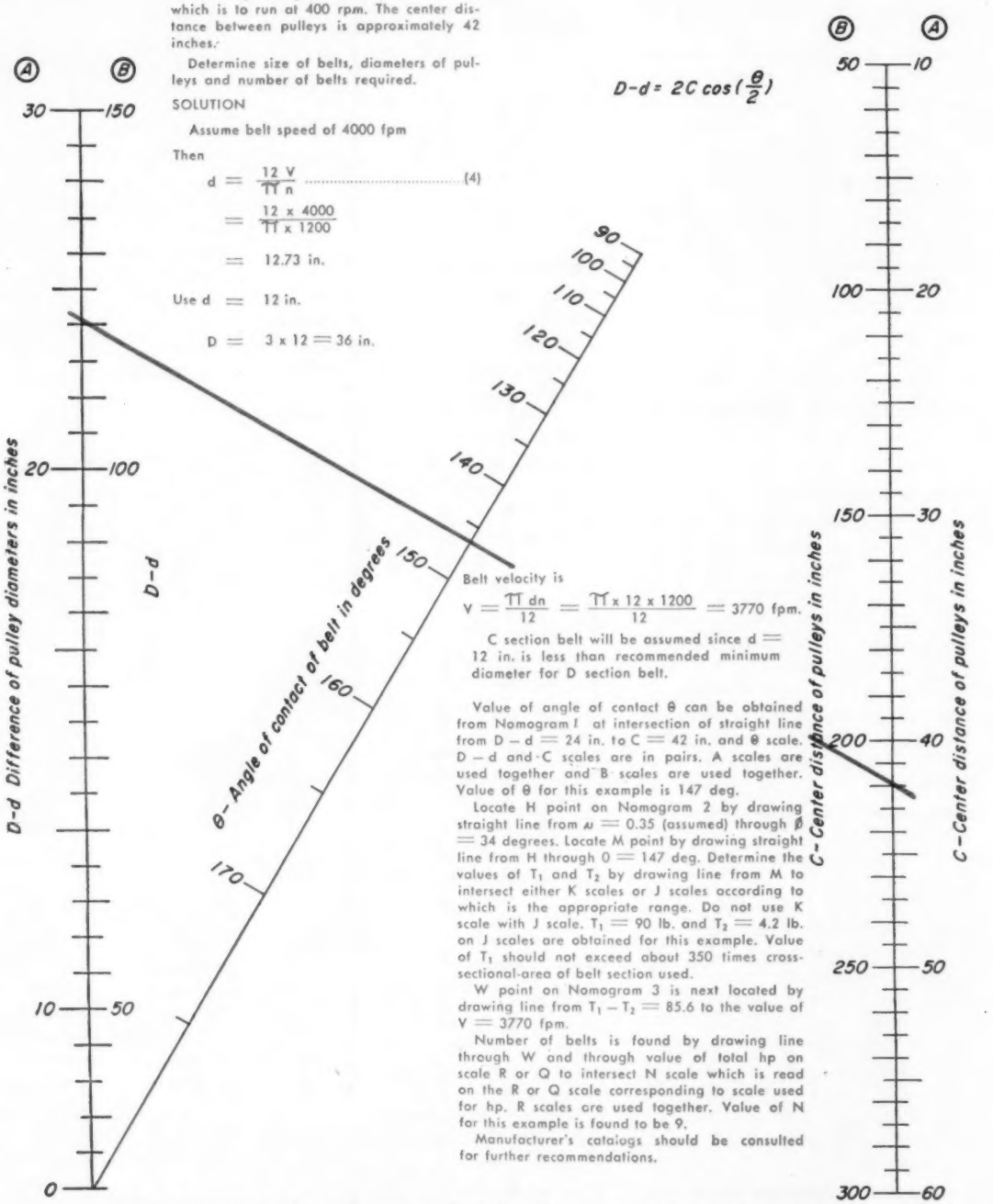
$$= \frac{12 \times 4000}{\pi \times 1200}$$

$$= 12.73 \text{ in.}$$

Use $d = 12$ in.

$D = 3 \times 12 = 36$ in.

$$D - d = 2C \cos\left(\frac{\theta}{2}\right)$$



Belt velocity is

$$V = \frac{\pi\,dn}{12} = \frac{\pi \times 12 \times 1200}{12} = 3770 \text{ fpm.}$$

C section belt will be assumed since $d = 12$ in. is less than recommended minimum diameter for D section belt.

Value of angle of contact θ can be obtained from Nomogram 1 at intersection of straight line from $D - d = 24$ in. to $C = 42$ in. and θ scale. $D - d$ and C scales are in pairs. A scales are used together and B scales are used together. Value of θ for this example is 147 deg.

Locate H point on Nomogram 2 by drawing straight line from $\mu = 0.35$ (assumed) through $\beta = 34$ degrees. Locate M point by drawing straight line from H through $\theta = 147$ deg. Determine the values of T_1 and T_2 by drawing line from M to intersect either K scales or J scales according to which is the appropriate range. Do not use K scale with J scale. $T_1 = 90$ lb. and $T_2 = 4.2$ lb. on J scales are obtained for this example. Value of T_1 should not exceed about 350 times cross-sectional-area of belt section used.

W point on Nomogram 3 is next located by drawing line from $T_1 - T_2 = 85.6$ to the value of $V = 3770$ fpm.

Number of belts is found by drawing line through W and through value of total hp on scale R or Q to intersect N scale which is read on the R or Q scale corresponding to scale used for hp. R scales are used together. Value of N for this example is found to be 9.

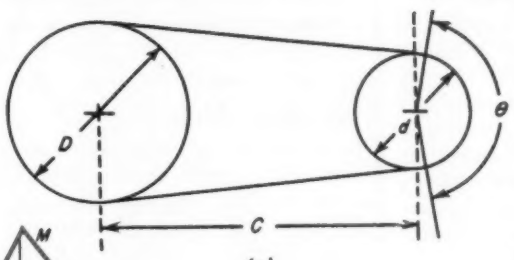
Manufacturer's catalogs should be consulted for further recommendations.

For a free reprint of four nomograms, circle No. 250 on the Reader Service Card

By J. N. ARNOLD, *professor, and*
ALLAN C. DUNK, *assistant professor, Purdue University*

Part 2
Two nomograms in next issue will complete series

V-belt drive installation PART 1



(a)

(b)

Following relationships are obtained:

$$HP = \frac{(T_1 - T_2)\,VN}{33000} \quad \text{.....(1)}$$

$$T_1/T_2 = \frac{\mu\theta}{e \sin(\phi/2)} \quad \text{.....(2)}$$

$$C = \frac{D-d}{2} \cos\frac{\theta}{2} \quad \text{.....(3)}$$

Where

- HP — total horsepower transmitted
- V — pitch line velocity of belt (fpm)
- N — number of belts
- T_1 — tight side tension per belt (lb)
- T_2 — slack side tension per belt (lb)
- n — pulley rpm
- e — naperian log base
- μ — coefficient of friction between belt and smaller pulley
- θ — angle of contact between belt and smaller pulley radians
- ϕ — pulley groove angle deg.
- C — pulley center distance inches
- D — diameter of larger pulley inches
- d — diameter of smaller pulley inches

The relationships of equations 1, 2 and 3 are derived by neglecting effect of centrifugal loading on belts. All belts of a drive are assumed to operate under identical conditions of tension, angle of contact and coefficient of friction. Service factors have not been applied.

For a free reprint of four nomograms circle No. 250 on the Reader Service Card

Catalog digest available

Comprehensive listing of many products is given in Digest 142, 160 pages well-illustrated. Specifications and prices on relays, starters, circuit breakers, safety switches, brakes, timers and many others. N. E. C. standards are included.

Square D Co., Milwaukee, Wisc.

Circle number 31 on reader service card

Engineering guide

Bulletin 314 covers specifications of fluid and friction drives. Construction details, dimensions, capacities and application recommendations are included in 20-page brochure.

Twin Disc Clutch Co., Racine, Wis.

Circle number 18 on reader service card

Bushings in use

Interesting illustrated 7-page booklet shows self-aligning bushings now in use in several types of oscillating applications. Case histories in areas of construction, paving, mining pit trucking, petroleum drilling, aircraft, bulldozer earth-moving, textiles and logging. Also included are dimensions, weights, capacities, shaft and housing fits and tolerances.

Roller Bearing Co. of America, West Trenton, N. J.

Circle number 32 on reader service card

Steel conveyors

Flat-Veyor is a stainless steel, precision-built chain and matching sprocket conveyor for smooth, strong handling purposes. Bulletin CD103 gives specifications.

Browning Mfg. Co., Maysville, Ky.

Circle number 2 on reader service card

Dry fluid drive

"Fluid" in Flexidyne drive is heat-treated steel shot. Measured amount is thrown between housing and rotor by centrifugal force. 24-page bulletin A640B, illustrated in color, shows typical applications, outlines selection factors in tabular form.

Dodge Mfg. Corp., Mishawaka, Ind.

Circle number 33 on reader service card

Speed reducers

Comprehensive line for all uses is described in product bulletins J17 (all-motor and integral type gearmotors), J18 (in-line helical reducers), J19 (shaft-mounted reducers), 100 (herringbone gear reducers), J13 (worm gear reducers), and J14 (worm-helical reducers).

Hewitt-Robins, Stamford, Conn.

Circle number 10 on reader service card

High-speed drives

Speedmaster drive units have heat-treated alloy steel double helical gears, cast or fabricated housings with integral oil sump, self-contained pressure-lubrication systems. Illustrated bulletin 5904 gives easy-to-find selection instructions, service factors, horsepower and ratio ratings, dimensions, ordering and application data, etc. for this extensive line.

Western Gear Corp., Industrial Products Div., Belmont, Calif.

Circle number 34 on reader service card

Clutches described

Morlife clutches reduce foot pedal pressure up to 50 percent, assure smooth pick-up and power-holding grip. Bulletin, entitled Clutches and Power Take-Offs, shows typical installations, gives full data.

Rockford Clutch Div., Borg-Warner Corp., Rockford, Ill.

Circle number 16 on reader service card

Angle gears

Selecting 90 degree power takeoffs for many applications is simplified by company literature showing design and construction features.

Airborne Accessories Corp., Hillside, N. J.

Circle number 1 on reader service card

Clutch conversion

Air friction clutch and brake suitable for reconditioning existing mechanical presses is outlined in interesting booklet CC57, 16 pages, well illustrated. Picture stories of actual press conversion installations show increased production and reduced maintenance. Actual clutch and brake assemblies are diagramed, with full control data and specifications included.

Minster Machine Co., Minster, Ohio.

Circle number 35 on reader service card

Flexible shafting

Catalog 250 gives details on use of flexible shafting for OEM uses. Standard sizes from ¼ to 1¼ in. with non-ravel cores.

B. W. Elliott Mfg. Co., Inc., Binghamton, N. Y.

Circle number 7 on reader service card

Lubrication systems

Role of modern centralized lubrication to reduce industrial operating costs and improve production is thoroughly discussed in 16-page illustrated brochure "Report to Management." Full discussion of economic factors, engineering advantages, methods of conversion, case histories and basic technical data.

Lincoln Engineering Co., Industrial Div., St. Louis, Mo.

Circle number 36 on reader service card

Simplified sheaves

QD (quick detachable) sheaves are easily installed, due to two-screw design. Clamp screw allows you to fix one part at a time, with no inching into place, and assures permanent alignment. Set screw prevents "key drift," avoids distortion. Sheaves are included in 100-page V-drive manual.

Worthington Corp., Oil City, Pa.

Circle number 21 on reader service card

Face-type seals

Bulletin AS01 describes mechanical seals with welded metallic bellows instead of spring or elastomer packings. Wider temperature range and pressure capabilities are obtained. Hydraulic balance adjustable by changing face diameters between mating surfaces. Handy charts provide data on dimensions and styles.

Sealol Corp., Providence, R. I.

Circle number 37 on reader service card

Compact V-belt

Reduced size, decreased costs are features of Super HC V-belt drives. Reduction of over-all drive costs up to 20 percent is claimed. Handbook is entitled "The Modern Way to Design V-Belt Drives."

Gates Rubber Co., Denver, Colo.

Circle number 9 on reader service card

Precision gears

New 100-page catalog of fine pitch precision stock gears. Lists stainless steel and aluminum spur gears, 48 through 200 pitch with solid and clamp-type hubs, AGMA precision class 1 and 2 standards. Also included are 48, 64 and 72 pitch stock miter and bevel gears; stainless steel and aluminum clamps; and plain type spur gears 48 through 120 pitch with solid hubs and clamp-type hubs for various assemblies.

U. S. Gear Corp., Wakefield, Mass.

Circle number 38 on reader service card

Royal V-belts

Belts of perfect match are available from stock in all sizes up to 180 in. No matching machine need be used for selecting drive needs.

U. S. Rubber Co., New York, N. Y.

Circle number 19 on reader service card

Ball bearing line

Form 1550-1 gives information on pillow blocks and flange units with Labri-Seal ball bearings. Advantages include a rotating finger, labyrinth seal and positive contact synthetic rubber seal.

Marlin-Rockwell Corp., Jamestown, N. Y.

Circle number 11 on reader service card

Slip clutches, couplings

For constant torque and tension, with overload protection and related safety benefits. Bulletin 300 is 10 pages, with diagrams of typical installations such as with speed reducers, conveyors and reduction gearing. Torque ranges from ½ in.-lb to 24,600 ft-lb in light or standard series. Bulletin also describes a special adjustable while-running slip clutch.

The Hilliard Corp., Elmira, N. Y.

Circle number 39 on reader service card

Unground bearing units

Offer substantial savings for many applications. Pillow-block and take-up units, several flange styles and special designs.

Roberts Mfg., Inc., Salina, Kan.

Circle number 15 on reader service card

Variable-speed line

Catalog P-58, 30 pages, well illustrated, shows large line of power transmission equipment, including variable-speed pulleys, V-belts, sheaves, motor bases, countershafts and Select-O-Speed transmissions for various speed ratios. Typical applications are well shown.

Lovejoy Flexible Coupling Co., Chicago, Ill.

Circle number 40 on reader service card

Versatile transmission

Up to 9 exact output speeds from one constant input speed. Specially designed for unusual uses.

Turner Uni-Drive Co., Kansas City, Mo.

Circle number 17 on reader service card

Shaft-mounted reducers

Torque-Arm speed reducers now are offered in 55 models, with capacities up to 170 hp, output speeds from 10 to 378 rpm. Torque-Arm mounts vertically or horizontally in any position around driven shaft.

Dodge Mfg. Corp., Mishawaka, Ind.

Circle number 5 on reader service card

Variable-speed units

MS pulley series has externally located resilient keys and rotational oil pumping action. No fretting corrosion, freezing, sticking. Bulletin 4101 describes operation in illustrated form, with information on related products like belts, companion pulleys and motor bases. Pitch diameters of 2:1 and 3:1, with horsepower ratings from .75 to 15.

T. B. Wood's Sons Co., Chambersburg, Pa.

Circle number 41 on reader service card

Bronze bearings

Completely finished cast bronze and sintered oil-filled bronze bearings are available in over 2000 sizes for all applications. Catalog 58 gives details on specifications and uses.

Bunting Brass and Bronze Co., Toledo, Ohio.

Circle number 3 on reader service card

Mounting facilities

Twelve-page bulletin 714 describes base assemblies and other systems for control of shock, noise, vibration. Special emphasis on applications in airborne controls and instrumentation, computers, radar units, magnetrons and missile projects. Recent work by the company is reviewed in terms of design and application, manufacture of parts and implications to other projects.

Lord Mfg. Co., Erie, Pa.

Circle number 42 on reader service card

Clutch pulleys

Variable-speed clutch pulley with a-c motor gives good performance at a fraction of the cost of variable-speed drives. For soft starts, easy acceleration, inching drives. Bulletin M-1 gives details.

Horton Mfg. Co., Inc., Minneapolis, Minn.

Circle number 22 on reader service card

Three-phase motors

Bulletin GEA-6932, two pages, illustrated, describes U. L.-listed inherent protection features for integral hp, three-phase motors for fan, blower and compressor applications. Description of product features, motor ratings, and connection diagrams for complete line.

General Electric Co., Schenectady, N. Y.

Circle number 43 on reader service card

ABSTRACTS *of current technical papers*

Fine-pitch worm and helical gear sets

E. D. KNAB, *Bell Telephone Laboratories, Inc.*

FINE-PITCH WORM GEARING can offer real savings, in both cost of gear trains and procurement time of parts. The present AGMA Standard 374.03 "Design for Fine-Pitch Worm Gearing," specifies a range of axial pitches and lead angles that provides adequate coverage and minimizes cost. Use of these standards, however, makes it impossible to design a worm and gear to a predetermined exact center distance except by coincidence.

Since gear sets must often be designed to exact center distances because of placement of components, use of the standard creates this problem. In practically all cases within the fine pitch range, the design can be done using worm and helical gear combinations instead of worms and worm wheels. In addition to being a substitute for the worm and worm wheel, a worm and helical gear set have definite advantages.

Two design approaches are covered in this article. One is for adjustable center distance; the other is for the exact fixed center distance. Although worm and helical gear sets may be operated with shafts at almost any angle, the methods and examples here are for shafts at 90 deg.

Design Approach

Worm gear set design usually begins with the worm. The worm in this case is a normal diametral pitch worm. Actually, it is a helical gear with one or more teeth, called threads or starts. As more starts are added to the worm, it will at some point resemble a helical gear. Although the dividing line is arbitrary, a diametral pitch worm is assumed to have from one to ten starts and a lead angle of not over 30 deg. Normal

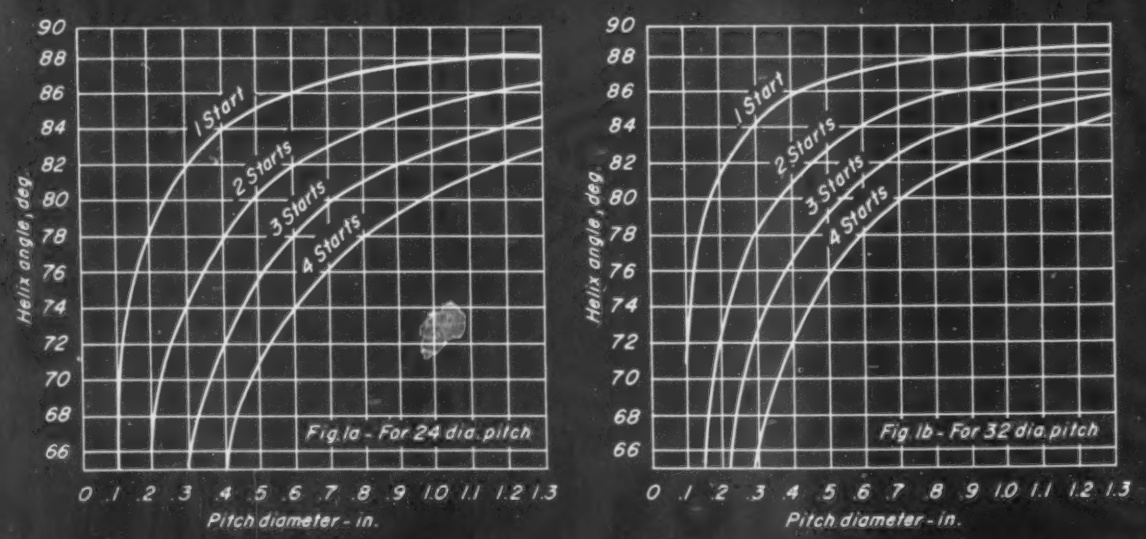


FIG. 1. CURVES of pitch diameter vs. helix angle for fine-pitch worms.

diametral pitches are: 20, 24, 32, 32, 48, 64, and 72. Normal pressure angle is always 20 degrees.

Mating helical gears may be generated with practically any helix angle within the range of lead angles established for the worm. Worm lead angle may, therefore, be selected to the nearest minute of arc approaching the calculated values. This way the worm and gear can be designed for an exact center distance.

Calculations—Case 1

Here center distance is an arbitrary value within a range determined by design of the equipment in which the gears must operate. Only known values are: approximate center distance, gear ratio, normal pressure angle, and total composite error. Values for normal diametral pitch, number of starts, worm helix angle, and approximate pitch diameter are selected from the curves of pitch diameter vs. helix angle, Figures 1a-1d. This quickly narrows the field of trial and error.

Example: Assume that known values are: $C_d = 1.2$ to 1.5 in., $R = 24/1$, $\Phi_n = 20$ deg, and TCE = 0.001 in. Then the following values are assumed for a first trial computation. $P_n = 24$, $_n = 4$, $\beta = 80$ deg, and d = 0.965 in. (from Fig. 1a). These are the steps.

1. $N = R/n = 24 \times 4 = 96$
2. $\Psi = 90° - \beta = 90° - 80° = 10°$
3. $D = \dfrac{N}{P_n \cos \Psi} = \dfrac{96}{24 \times .98481} = 4.0617$ in.
4. $d = \dfrac{n}{P_n \cos \beta} = \dfrac{4}{24 \times .17365} = .9598$ in.

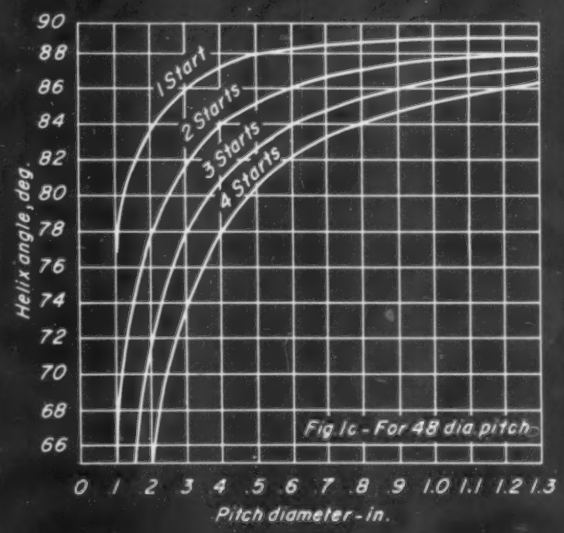
Nomenclature

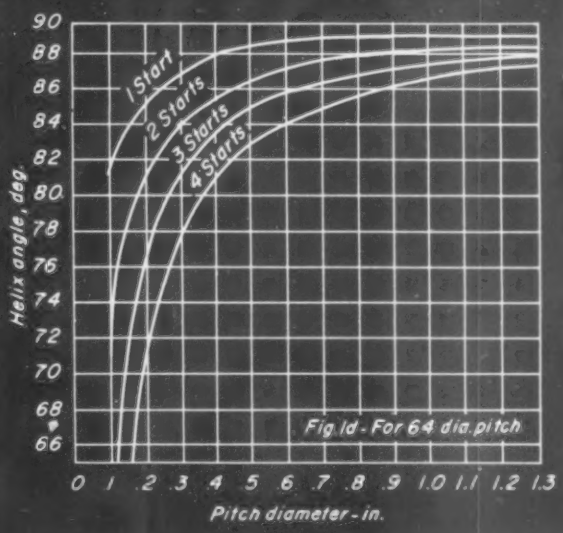
a	=	Addendum = $1/P_n$
C_d	=	Center distance (min)
D	=	Pitch diameter of gear
d	=	Pitch diameter of worm
D_o	=	Outside diameter of gear = $D + 2/P_n$
d_o	=	Outside diameter of worm = $d + 2/P_n$
F_W	=	Min. length of worm
h_t	=	Whole depth = $2.2/P_n + .002$
h_w	=	Working depth = $2a$
L	=	Load of gear
l	=	Load of worm
N	=	No. of teeth in gear
n	=	No. of teeth in worm
P	=	Diametral pitch in plane of rotation = $P_n \cos \Psi$
P_n	=	Normal diametral pitch
R	=	Ratio = $N/_n$
TCE	=	Total composite error of gear
β	=	Helix angle of worm
ϕ	=	Pressure angle in plane of rotation
ϕ_n	=	Pressure angle (normal)
Ψ	=	Helix angle of gear
Ψ_t	=	Helix angle of gear (tentative)

5. $C_d\ (\text{min.}) = \dfrac{D + d}{2} + \text{TCE} + .001 =$

$$\frac{4.0617 + .9598}{2} + .001 + .001 = 2.5128''$$

Continued on next page





The quantity TCE + 0.001 in the preceding equation is added to the basic center distance to allow for gear, shaft, and bearing eccentricity. If differential expansion due to temperature is expected, the allowance should be increased.

The answer gotten in step 5 is much too large. Therefore, another trial calculation must be done. This time, assumed values are: $P_n = 24$, $n = 1$, $\beta = 88$ deg, and $d = 1.2$ (from Fig. la. Following the same five steps of calculation, the new value of C_d is found to be 1.0993 in. This value is too small for the required center distance range and a third try is needed.

Now, the assumed quantities are: $P_n = 48$, $n = 4$, $\beta = 80$ deg, and $d = 1.2$ (from Fig. la). This time following steps 5—7 gives an answer of 1.2574 which is within the required range. Values of D and d gotten in steps 5 and 6 are 2.0308 and 0.4799 in. respectively. These values are now used to continue the computations.

6. $l = \pi d \tan \Psi = 3.1416 \times .4799 \times 17633 = 266$ in.
7. $L = \pi D \tan \beta = 3.1416 \times 2.0308 \times 5.6713 = 36.1827$ in.
8. $D_o = D + \frac{2}{P_n} = 2.0308 + \frac{2}{48} = 2.0724$ in.
9. $d_o = d + \frac{2}{P_n} = .4799 + \frac{2}{48} = .5215$ in.
10. $a = \frac{1}{P_n} = \frac{1}{48} = .0208$ in.

Table I—Worm and Helical Gear Manufacturing Information

Backlash	**Whole depth (minimum)**
Number of teeth or starts	**Gauge or pin or wire diameter**
Diametral pitch (normal)	**Measurement over wires**
Pressure angle (normal)	**Helix angle or lead angle**
Method of manufacture	**Hand of Helix**
Pitch diameter	**Lead**
Addendum	**AGMA classifications**
Working depth	

Table 2—OD Tolerance VS. Pitch

Diametral Pitch	OD tolerance all +.000 (in.)
20	**—.010**
24	**—.008**
32	**—.006**
48	**—.004**
64	**—.003**
72	**—.002**

11. $h_w = 2a = .0416$ in.
12. $h_t = \frac{2.2}{P_n} + .002 = .0478$ in.
13. $F_W = \sqrt{D_o^2 - D^2} = \sqrt{.1707} = .4132$ in.

Calculations—Case 2

In this instance, known quantities are: center distance, C_d, which is exact, ratio, R, and normal pressure angle Φ_n. Values used are: $C_d = 1.2574$, $R = 24/1$, $\Phi_n = 20$ deg, and TCE = 0.001 in. Assumed quantities are $P_n = 48$ and $\Psi_t = 15$ deg. Since the value of C_d is exact, it must be reduced by TCE + 0.001 in. for calculation, so the gears will operate without interference from eccentricity of gears, shafts, and bearings.

Sample calculations are as follows.

1. $$n = \frac{2[C_d - (TCE + .001)]P_n \sin \Psi_t}{1 + R \tan \Psi_t} = \frac{2.5108 \times 48 \times .25882}{1 + 24 \times .26795} = \frac{31.19257}{7.4308} = 4.198$$
   Taking the nearest whole number, $n = 4$,
2. $N = R \times n = 24 \times 4 = 96$
   If $R = p/q$ where p and q are integers, and n is such that N does not result in an integer, then n must be increased or decreased so that N becomes a whole number.
3. $$R \sec \Psi + \csc \Psi = \frac{2[C_d - (TCE + .001)]P_n}{n} = \frac{2.5108 \times 48}{4} = 30.1296$$
   Solving 3. by trial and errror to the nearest minute of arc, $\Psi = 10°$
4. $\beta = 90° - \Psi = 90° - 10° = 80°$
5. $d = \frac{n}{P_n \cos \beta} = \frac{4}{48 \times .17365} = .4799$ in.
6. $D = \frac{N}{P \cos \Psi} = \frac{96}{48 \times .98481} = 2.0308$ in.
7. $l = \pi d \cot \beta = 3.1416 \times .4799 \times .17633 = .266$ in.
8. $L = \pi D \cot \Psi = 3.1416 \times 2.0308 \times 5.6713 = 36.1827$ in.
9. $D_o = D + \frac{2}{P_n} = 2.0308 + \frac{2}{48} = 2.0724$ in.
10. $d_o = d + \frac{2}{P_n} = .4799 + \frac{2}{48} = .5215$ in.
11. $a = \frac{1}{P_n} = \frac{1}{48} = .0208$ in.
12. $h_w = 2a = .0416$ in.
13. $h_t = \frac{2.2}{P_n} + .002 = .0478$ in.
14. $F_w = \sqrt{D_o^2 - D^2} = \sqrt{.1707} = .4132$ in.

Manufacturing Information

Method of manufacture for the worm is similar to that of helical gears. Within certain limits, the worm may be hobbed or ground using standard tooling and gear generating equipment. Manufacturing drawings for the worm or helical gear should specify the items listed in Table 1.

Inspection or manufacturing tolerances are applied to values computed for measurement over wires, lead or helix angle, and outside diameters of both worm and helical gear. Since lead and helix angle are directly related, tolerance for only one must be specified. If lead is used, tolerance is $\pm 1\%$ of its value. If helix angle is used, tolerance is $\pm$ 0 deg 5 min of arc. OD tolerance varies with pitch; values are given in Table 2.

Advantages

There are three distinct advantages to using this type of gearing. They are:

1. Both worm and gear may, in many cases, be manufactured on standard spur gear generating equipment.
2. Both worm and gear may be manufactured and inspected independently.
3. Critical axial alignment at assembly is not necessary as it is with worms and worm gears where the worm threads and gear teeth must be accurately aligned to insure proper tooth bearing.

It should be pointed out that tooth contact between the worm thread and gear tooth is only point contact. Therefore, this type of gearing is limited to transmission of power at moderately light loads at relatively low speeds. ▲▲▲

This article was abstracted from a paper presented at the Annual Meeting of the American Gear Manufacturers Association, Hot Springs, Va., June, 1959.

BALL BEARINGS ***continued from page 52***

Values of X,V, and Y are given in Fig. 2. Factor V, due to lack of sufficient experimental evidence, should be used as a matter of precaution.

This data is limited to bearings whose ring raceways have a cross-sectional radius not larger than (1) 52 per cent of the ball diameter, for deep groove and angular contact ball bearing inner rings (2) 53 percent of the ball diameter, in deep groove and angular contact ball bearing outer rings, (3) 53 percent of the ball diameter, in self-aligning ball bearing inner rings.

Basic load rating is not increased by using smaller groove radii, but is reduced by the use of larger radii than those given in table. ▲▲▲

Portions of this article adapted from ASA and AFBMA standards.

ADVERTISERS INDEX

Airborne Accessories Corp. 13
Automation Industries, Inc. 12

Browning Mfg. Co. 8
Bunting Brass and Bronze Co. 40

J. D. Christian Engineers 32
Cone-Drive Gears, Div. of Michigan Tool Co. 22

Dodge Mfg. Corp. 37
Durkee-Atwood Co. 5

Elliott Mfg. Co. 14
Euclid Universal Machine, Inc. 2

Gates Rubber Co. 34

Hewitt-Robins 9
Hilliard Corp. 12
Horton Mfg. Co. 55

Marlin-Rockwell Corp. 21
Maurey Mfg. Corp. 1
Mechanics Universal Joint Div., Borg-Warner Corp. .....Cover II

Peerless Electric Co. 3

Roberts Mfg. Co. 55
Rockford Clutch Div., Borg-Warner Corp. 11

Turner Uni-Drive Co. 63
Twin Disc Clutch Co. 7

U. S. Rubber Co. 15

Warner Electric Brake and Clutch Co. .....Cover III
Worthington Corp. 27

PRODUCT INDEX

Actuators: 13, 35, 38

Bearings: 8, 21, 28, 29, 30, 40, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 54, 55, 59
Belt drives: 1, 5, 15, 18, 19, 20, 25, 30, 33, 34, 38, 55, 56, 57, 59
Brakes: 26, 55, Cover III
Bushings: 33, 58

Chain drives: 1, 8, 18, 19, 20, 30, 33
Clutches: 7, 11, 16, 17, 24, 25, 30, 33, 39, 54, 55, 58, 59, Cover III
Controls: 12, 38, Cover III
Couplings: 7, 8, 26, 55, 59

Gears: 6, 7, 18, 19, 20, 30, 38, 58, 59, 60, 61, 62
Gear drives: 2, 13, 22, 30
Gearmotors: 9, 24, 25, 32, 35, 36, 38

Lubrication systems: 35, 55, 58

Motor Bases: 59
Motors, electric: 3, 12, 26, 28, 29, 35, 36, 55, 59
Motors, hydraulic: 16, 17, 23, 24

Pillow blocks: 25, 36
Power take-offs: 7, 11, 13, 21, 58
Pulleys: 1, 8, 38, 59

Seals: 21, 58
Shafts: 14, 16, 17, 30, 58
Sheaves: 1, 5, 25, 27, 30, 34, 56, 57, 58, Cover III
Speed Reducers: 2, 9, 11, 16, 17, 22, 23, 24, 28, 29, 32, 35, 36, 37, 38, 55, 58, 59
Sprockets: 1, 8, 30

Universal joints: Cover II, 30, 55

Variable-speed electrical drives: 38, 55
Variable-speed hydraulic drives: 12
Variable-speed mechanical drives: 1, 8, 38, 59

For New Product information or Literature, circle Reader Service Card from this list.

NEW PRODUCTS

start on page 33 — *Circle no.*

Self-lubricated chain 100
Whitney Chain Co.
Versatile light-duty V-belts 101
Raybestos-Manhattan, Inc.
Long-life overrunning clutches ..102
Formsprag Co.
New fan motor 103
Louis Allis Co.
Small gearmotor 104
Western Gear Corp.
Submersible motor 105
Louis Allis Co.
Precision limit switches 106
Cutler-Hammer, Inc.
Oiler brushes 107
Oil-Rite Corp.
Cargo torque meters 108
Metron Instrument Co.
Gear speed reducers 109
Philadelphia Gear Corp.
Pillow blocks 110
Jolico Industries
Reversing transmission 111
Mentor Products, Inc.
Universal-mounting gear unit ...112
Crofts U.S.A., Inc.
Double shaft gearmotor 113
Western Gear Corp.
Timing belt drive 114
Allis-Chalmers Mfg. Co.
Compact gearmotor 115
New England Gear Works
Speed reducer line 116
Ohio Gear Co.
Key starter 117
General Electric Co.
Control units 118
Cycledynamics Inc.
Variable-speed pulley 119
Lovejoy Flexible Coupling Co.
Marine gearing 120
Western Gear Corp.
Safety clutch line 121
Edgemont Machine Co.

LITERATURE

starts on page 55 — *Circle no.*

Bearing line 25
Roller Bearing Co. of America
Universal joint 13
Mechanics Universal Joint Div.
New a-c contactor 26
Allis-Chalmers Mfg. Co.
V-belt catalog 12
Maurey Mfg. Corp.
Universal motors 27
Robbins & Myers, Inc.
Clutch-brake control 20
Warner Electric Brake & Clutch Co.
Coupling line 28
Browning Mfg. Co.
Speed reducers 8
Euclid Universal Machine, Inc.
Bearing lubrication 29
Miniature Precision Bearings, Inc.
Torque motors 14
Peerless Electric Co.
Long-lived parts 30
Pittsburgh Gear Co.
Improved V-belts 6
Durkee-Atwood Co.
Catalog digest available 31
Square D Co.
Engineering guide 18
Twin Disc Clutch Co.
Bushings in use 32
Roller Bearing Co. of America
Steel conveyors 2
Browning Mfg. Co.
Dry fluid drive 33
Dodge Mfg. Corp.
Speed reducers 10
Hewitt-Robins
High-speed drives 34
Western Gear Corp.
Clutches described 16
Rockford Clutch Div.
Angle gears 1
Airborne Accessories Corp.
Clutch conversion 35
Minster Machine Co.
Flexible shafting 7
B. W. Elliott Mfg. Co., Inc.
Lubrication systems 36
Lincoln Engineering Co.
Simplified sheaves 21
Worthington Corp.
Face-type seals 37
Sealol Corp.
Compact V-belt 9
Gates Rubber Co.
Precision gears 38
U. S. Gear Corp.
Royal V-belts 19
U. S. Rubber Co.
Ball bearing line 11
Marlin-Rockwell Corp.
Slip clutches, couplings 39
The Hilliard Corp.
Unground bearing units 15
Roberts Mfg., Inc.
Variable-speed line 40
Lovejoy Flexible Coupling Co.
Versatile transmission 17
Turner Uni-Drive Co.
Shaft-mounted reducers 5
Dodge Mfg. Corp.
Variable-speed units 41
T. B. Wood's Sons Co.
Bronze bearings 3
Bunting Brass and Bronze Co.
Mounting facilities 42
Lord Mfg. Co.
Clutch pulleys 22
Horton Mfg. Co., Inc.
Three-phase motors 43
General Electric Co.

electric motion control facts

for IDEA MEN

Warner clutch-brake key to all-out modernization

Electric motion control replaces 1000 lb of hardware. Improves power transmission, simplifies control.

Here is a good example of how easily obsolete machinery can be repowered, modernized, and made more productive without costly equipment.

By using a Warner electric clutch-brake for starting and stopping the motor drive, the owner of a 60" vertical boring mill was able to replace an old-fashioned cone drive and inefficient wide belting to gain two important advantages:

1. Direct electrical operation permits use of full pushbutton control without actuating solenoids or high-pressure piping.

2. Split-second engagement and release (a unique feature of electric brakes and clutches) increases machine productivity and permits highly accurate table positioning.

One thousand pounds lighter

In converting to individual motor drive, all flat belting, friction clutches, brakes, and cone pulleys were removed—in all, over 1000 lb.

A variable speed gearbox provides a wide range of table speeds. Multiple-groove sheaves and V-belts eliminate slippage and power loss. And, a Warner 1525-1225 primary clutch-brake tied all these features together in a fast-acting, push-button-controlled package.

New control simple, fast

In operation, power for the table goes from the gearbox to a bearing-mounted Warner 1525 clutch armature, mounted to the drive sheave. The clutch magnet is mounted to the table drive shaft. When energized, the powerful electromagnet attracts the armature, locking it (and its integral sheave) in full couple. This transmits power from the sheave to table.

For braking, the brake armature is mounted to the table drive shaft—the magnet to the machine frame. Pushing the stop button actuates a relay, de-energizing the clutch and energizing the brake. The stationary magnet attracts the rotating armature, stopping the drive shaft.

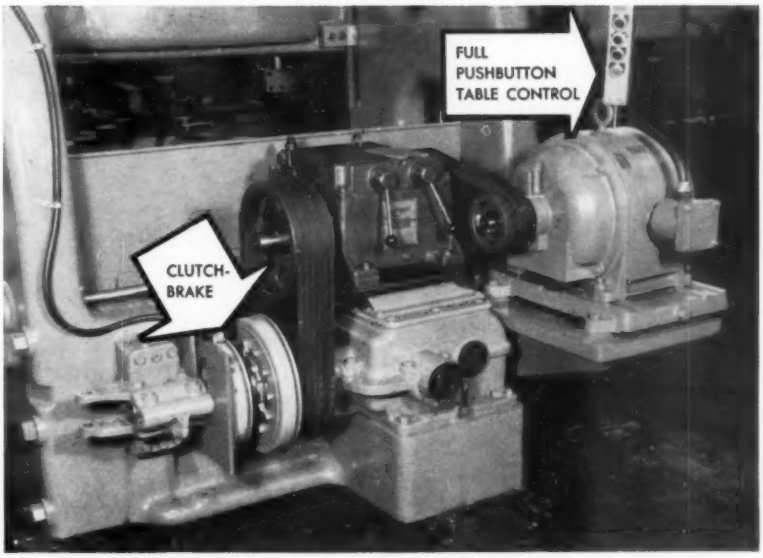


Fig. 2—Replacing outdated wide belting and cone pulleys, this new table drive for a vertical boring machine features fast-acting electric clutch-brake with convenient pushbutton pendent control.

Adds other advantages, too . . .

In addition to those already mentioned, the Warner electric clutch-brake offers the following benefits: 1) stepless torque modulation for varying engagement and release times; 2) automatic wear adjustment and low maintenance; 3) no-load starting; 4) low power consumption; and 5) longer motor life.

Want more ideas?

For factual case histories showing how machinery can be made easier to control, simpler to maintain, and more productive, contact your local Warner representative or send coupon below.

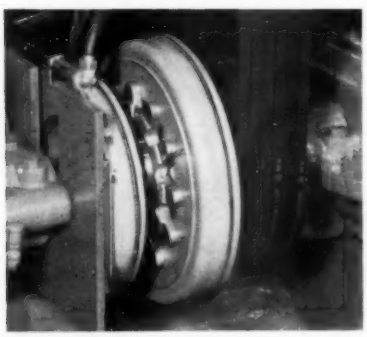


Fig. 1—Compact Warner clutch-brake, with integral five-groove V-belt sheave, meets tight space requirement. Complete assembly fits between bearings 13" apart.

WARNER

Originators of electric motion control

Warner Electric Brake & Clutch Co.

Dept. PTD, Beloit, Wisconsin

Please send literature describing Warner electric clutch-brakes.

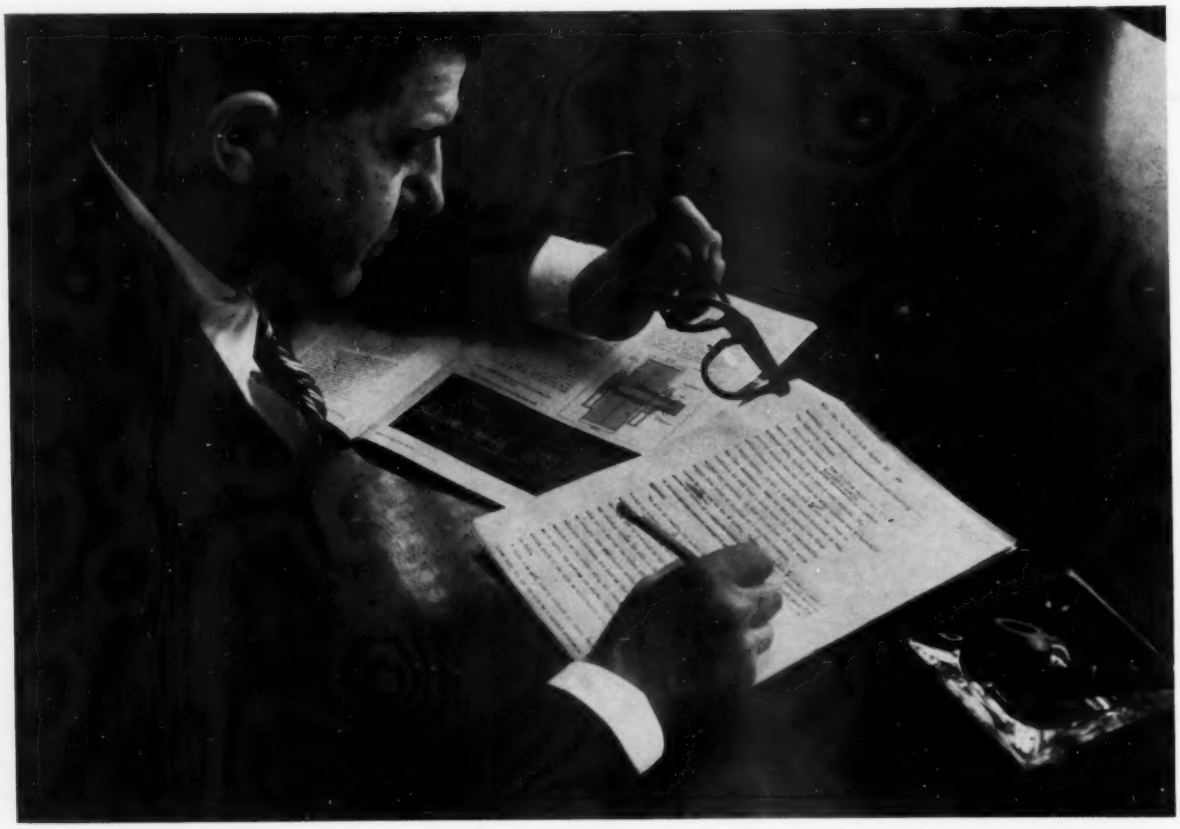
Name_____ Title_____

Company_____

Address_____

City_____ Zone_____ State_____

For more information circle No. 20 on the Reader Service Card



DISTILLED WRITING REWARDS THE READER

On POWER TRANSMISSION DESIGN, Distilled Writing is under the direction of David Kinsler who works with the editors until the extra words are squeezed out of their copy.

Result: bright, concise, easy-to-read content that makes every issue a quick, convenient source of information. Articles are shorter . . . making room for more articles of interest to you.

This editorial quality control assures you more for your reading time. You get all the facts clearly, simply and briefly as possible. Distilled Writing makes POWER TRANSMISSION DESIGN more rewarding to you.

Franchise Circulation gets magazines to the men who buy

Distilled Writing gets magazines read

POWER TRANSMISSION DESIGN

Published by Power Publishing Company, Inc.
Subsidiary of The Industrial Publishing Corporation
812 Huron Road • Cleveland 15, Ohio • SUperior 1-9620
Sales Offices: New York • Chicago • Los Angeles • London, England